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ABSTRACT

Providing general specifications and system descriptions for segments within the Arizona TeleMedicine Project (a telecommunication system designed to deliver health services to rurally isolated American Indians in Arizona), this document, when used with the appropriate route segment document, will completely describe the project's required communication facilities (radio, studio, and terminal equipment). Major topics presented include: (1) Scope (communications medium and channels, switching, and compatability); (2) System Design (design objectives; signal routing, switching, and system management; control console equipment; equipment licensing; etc.); (3) Applicable Documents (Electronic Industry Association Standards; Federal Aviation Regulations; etc.); (4) Transmission Performance Requirements; (5) Equipment Performance Requirements (video; magnetic tape recorders and playback units; switcher matrices; teleprinter; facsimile; etc.); (6) Other Technical Requirements (cable; prefabricated shelters; towers, antennas, and radomes; failure alarms; order wire; frequency shift key equipment; lighting; etc.); (7) Quality Assurance (acceptance test plan; test procedure and schedule; factory tests; etc.); (8) General Conditions and Instructions to Contractor (definitions; materials and employees; preconstruction submission of drawings; subcontracting; licenses, permits, taxes, and wages; etc.). (JC)

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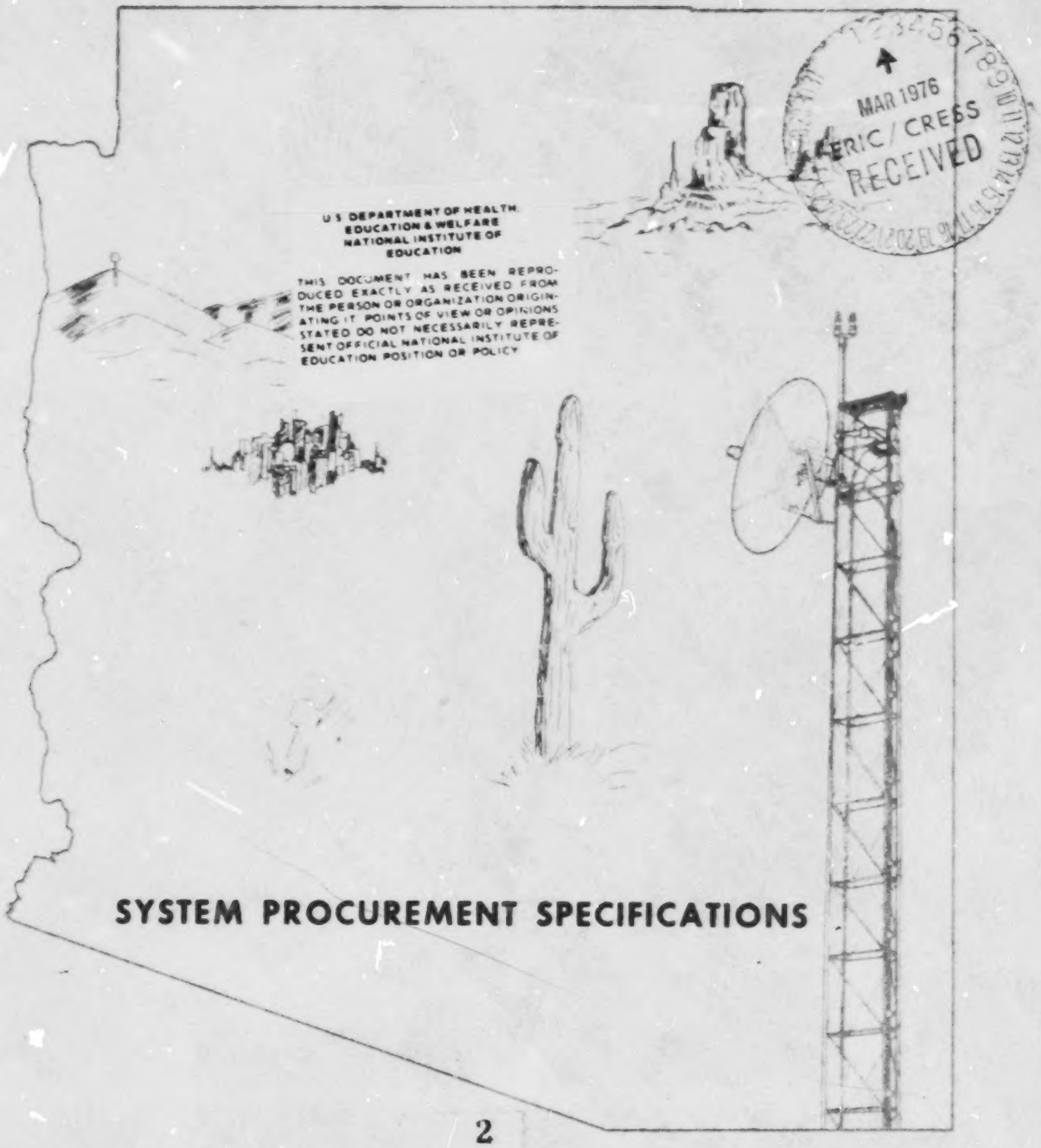

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SYSTEM PROCUREMENT SPECIFICATIONS

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UNIVERSITY OF ARIZONA, COLLEGE OF MEDICINE

RC009026

THE ARIZONA TELEMEDICINE NETWORK

SYSTEM PROCUREMENT SPECIFICATIONS

Prepared for:

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Tucson, Arizona 85724

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1.0 SCOPE

1.1 General

This document provides general specifications and system description for segments within the Arizona TeleMedicine Project. It is intended that this specification in conjunction with the appropriate route segment document shall completely describe the required communications facilities (radio, studio, and terminal equipment) to meet the objectives of the Arizona TeleMedicine Project for each segment of the network.

Unique information regarding individual segments is presented in the appropriate segment document. This includes description of the sites, path profiles, photographs, site maps and other necessary data and drawings. The proposed Arizona TeleMedicine Network is shown in Figure 1.1.

1.2 Communications Medium

Sites shall be interconnected using microwave radio with the exception of a few short cable links in some segments. Full duplex communications links are required in all cases except as noted in segment specifications.

Provision shall be made for future leased telephone company wireline circuits to interconnect the San Xavier relay with the Bell Aerospace Computer currently used by the Indian Health Service's Health Information System (HIS).

1.3 Communications Channels

The full duplex microwave links and short cable links shall be channelized to carry the following services.

- Full color television (525 line/30 frame with 5.5 MHz bandpass) – one channel
- Program Audio (15 kHz bandpass) – one channel
- Order wire (with selective signaling) – one channel

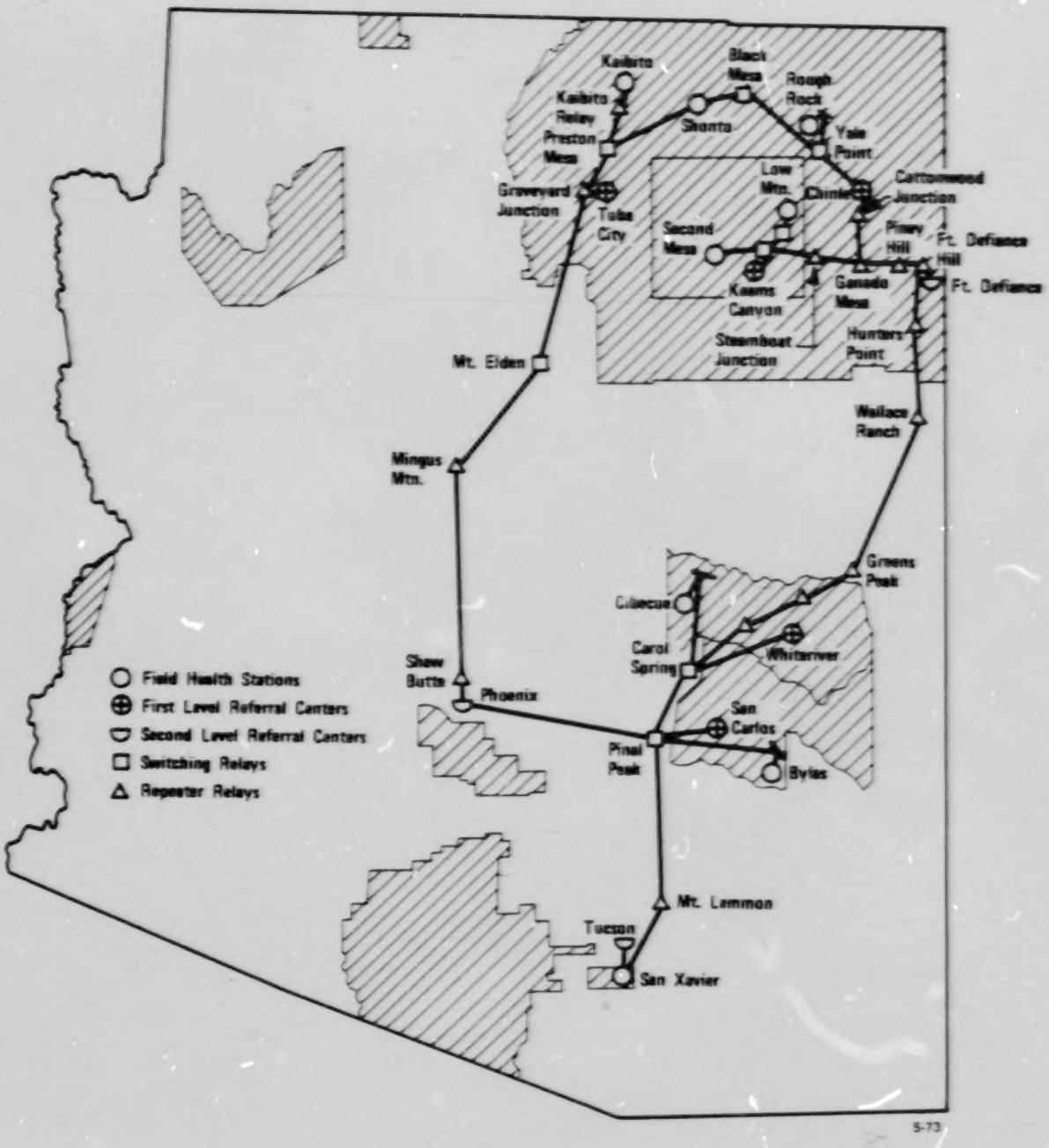

Figure 1.1. Proposed Arizona TeleMedicine Network.

- "Voice" slots (FDM, 4 kHz spacing) – 12 channels[1]

- Alarm circuits – as specified.

A further breakdown of the use of the "voice" slots is included in the suggested spectrum utilization plans for each link (see segment document).

The designated voice slots shown are to be used for the following services:

- Camera positioning control (tilt, pan, focus, zoom, iris, mono/color) – six channels (dc control) per voice slot

- Teleprinter/keyboard (300 baud – six channels per voice slot, one channel per site

- Telemetry (IRIG Standard) dc to 500 Hz – one channel, single voice slot per site

- Slow-scan television (approximately one frame per two-minute interval) – one channel, single voice slot

- Switching control relay sites, remote – touch tones, share administrative voice slot

- Administrative Voice Channel(s) – voice slots as required.

Locations in the network shall be provided with modems, FSK transmitter/receivers, FM telemetry devices and such required interface equipment so as to facilitate these services at each terminal site.

1.4 Switching

Certain stations in the network shall have the capability of the control of route switching matrices located at various points throughout the network. Switching shall be independent for each of the following three services: color television (audio follow video); telemetry and slow-scan TV. No switching is required for the teleprinter service or for the dedicated voice channels (order wire and intercom or "Administrative Voice Channel").

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[1] Exact number actually provided depends on the position of the link in question as related to the terminal sites served.

1.5 Compatibility

All construction shall be fully consistent with the statewide plan as shown on Figure 1.1. Such expansion possibilities shall be taken into account by the Contractor in his work.

2.0 SYSTEM DESIGN

2.1 Introduction

This section of the specifications document will describe the plan of the major statewide network and the philosophy behind its conceptual design. The Contractor shall regard these discussions as an integral part of the System Procurement Specifications.

2.2 Purpose of the Network

The purpose of the medical communication network is to alleviate the barriers and expand the availability of effective delivery of health services. These barriers are the ancient ones of time, geography and weather which tend to disrupt communication between health service providers involved in training, clinical support and delivery of health services and the recipient of health services. These professional contacts and support relationships are the actual core of the health services system. The proposed communication network permits these barriers to be circumvented, provides a system of professional support between physicians, community hospitals, metropolitan medical centers and the Community Health Medics.

The need to improve the delivery of health service to remote Indian reservations is great. The Indian population is currently served by the Indian Health Service which maintains medical field stations, area and peripheral hospitals to accomplish its mission. Chronic shortages of health care personnel in remote areas combined with the logistical problems associated with serving a large low density population has hampered the achievement of optimal health care.

The personnel shortage is alleviated somewhat by the increasing availability of Community Health Medics (CHMs), Indian men and women with backgrounds in the health field, who are qualified under medical supervision to deliver primary health services in independent or semi-independent situations on the reservations. This communication network will bring the resources of the medical center to support and maintain the CHM at a high professional level and will help to further expand, improve and integrate the efforts of the Indian Health Service.

2.3 Basic Design Objectives of the Network

The basic design objectives of the communications network are to:

- Link or be available to 100 percent of the designated population groups
- Enhance care in the home locale of the patient and family insofar as practical (and consistent with quality treatment)

- Expedite specialized primary health care delivery and where practical to deliver care for those individuals requiring secondary and tertiary care beyond the present scope of primary service system

- Be patient acceptable and in harmony with his personal customs and concern for privacy

- Be user acceptable and in harmony with legal requirements and the skills of the professional health care providers

- Be responsive in terms of cost and task effectiveness to the associated or anticipated activities of the sponsor

- Be accessible both in terms of 24 hours a day time access and geographic flexibility

- Be reliable and fail safe

- Be easily operable by health-service personnel.

2.4 Geographic Scope of the Master Plan

The proposed health communication system will eventually link five Indian reservations in Arizona. These reservations are:

a. Papago

b. San Carlos Apache

c. White Mountain Apache

d. Navajo

e. Hopi

In collaboration with the Indian Health Service and tribal representatives, field health stations, area and peripheral hospitals will be linked by a communications network. In addition to facilities in

remote areas, urban medical centers representing the most advanced medical techniques will be part of the network. These centers are the Phoenix Indian Medical Center (PIMC) and the University of Arizona Medical Center (UAMC). When fully established, the network will integrate the above mentioned health service facilities and be capable of providing the Indian population with comprehensive, high quality health care. Ultimately an expansion of this network will provide improvements in health services to other rural or isolated regions characterized by chronic shortages of health personnel.

2.5 Information Handling Requirements

The Arizona TeleMedicine Network will be required to transfer the following types of information.

Types of Data	Communications Mode
Input/output terminals for computer systems	Narrowband – digital data circuits
Voice	Narrowband – telephone grade circuits
Physiological signals such as respiratory rates and volumes, electrocardiographic signals, heart sounds, voice or other high quality audio data with a high content of low frequency information	FM telemetry – within a voice grade channel
System supervisory voice and signaling	Narrowband – telephone grade intercom circuits
Photographs, charts, X-rays, visual examination of subjects, prescription orders, hand or typewritten material, diagnostic/ therapeutic sketches, strip chart tracings (ECG, PCG, etc.)	Narrowband – facsimile and/or slow-scan TV
Live (real time) visual examinations of subjects in color, interactive, video educational material	Wideband – video grade duplex TV transmission circuits
Live (real time) visual examination of subjects in black and white, interactive, video educational material	Wideband – video grade duplex TV transmission circuits

2.6 Selection of Microwave Routes

The selection of relay points and microwave routes to be used throughout the Arizona TeleMedicine Network were based upon the need to provide the most efficient point-to-point paths. Route selection was influenced by the desire to share existing facilities wherever possible. A communication facility survey was undertaken to determine the location of facilities feasible for sharing. From this survey, certain facilities were identified as feasible for sharing of site and/or towers and buildings. The microwave route was planned accordingly. The Contractor shall seek joint-use agreements with these identified sites. The University of Arizona and the Indian Health Service will assist where possible in obtaining joint and land use agreements. The Contractor is cautioned to verify all path profiles before construction. Any deviation from the suggested routes must be justified and approved by the Project Director before construction.

2.7 Signal Routing, Switching, and System Management

2.7.1 General

In selecting the switching plan for signal routing, control and network management, several factors were taken into account. The switching plan must be compatible with the existing referral pattern; it must be reasonably simple from the operator's standpoint; and it must reflect in its technical design the need and desire for localized control. In specifying "localized control," the intent is to avoid a network where all communications are channeled through or solely under the control of a single centralized agency. Naturally, the switching plan must, without compromising effectiveness, be optimized for economy and use of the limited radio spectrum.

2.7.2 Classification of Network Stations

The relay and terminal sites of the Arizona Health Network for the purpose of definition will be classified into the following groups:

Class "a": Field health stations

Class "b": First level referral centers (peripheral hospitals)

Class "c": Second level referral centers (major medical centers)

Class "R1": Switching relays

Class "R2": Repeater relays

By definition, field health stations (Class "a" stations) shall be the "front line" with the least concentration of specialized skills. A few examples within this classification are the facilities at Bylas, Cibecue, Low Mountain and Kaibito.

First level referral centers (Class "b" stations) are those medical facilities that normally could be expected to provide backup support directly to the field health stations. As is currently the case with physical referral, the first level referral centers would accept, via the telemedicine network, cases deemed beyond the scope of the field health stations to handle. San Carlos, Whiteriver, Tuba City and Keams Canyon are examples of Class "b" stations.

Class "c" stations, as a group, will consist of all other terminal sites in the network. These sites are defined as the major medical centers in the health care system to which cases are referred that cannot be effectively handled at either the field health stations or the first level referral centers. The medical centers at Phoenix, Tucson and Fort Defiance are Class "c" stations.

The switching relays, Class "R1" stations, are radio relay stations that serve as intermediate stations for the transfer of signals between three or more stations of any type. Control of the route switching equipment at the switching relays would rest with the nearest associated Class "b" or Class "c" station. Pinal Peak, Keams Canyon Relay and Ganado Mesa are examples of Class "R1" stations.

Class "R2" stations, repeater relays are defined as those stations that provide full duplex interconnect facilities between two other stations of any type. Shaw Butte, Greens Peak and Cottonwood Junction are examples of Class "R2" stations.

2.7.3 Referral Pattern

The following example referral pattern was used in assigning switching responsibilities.

Class "a"	Class "b"	Class "c"
Rough Rock	to Chinle	to Ft. Defiance
Low Mountain	to Keams Canyon	to Phoenix or Ft. Defiance
Cibecue	Whiteriver	to Phoenix
Bylas	to San Carlos	to Phoenix

2.7.4 Communication Service

Between Class "a" stations and Class "b" stations, the following communication services shall be provided.

Description	Requirement	Bandpass	Switching
Administrative (coordination) voice channel	1 – duplex	300 to 3,000 Hz	None, dedicated channel
Video channel[1] (525 line/30 frames)	1 – duplex	0 to 5.5 MHz	Controlled by Class b/c
Program voice channel (associated with video)	1 – duplex	30 to 15,000 Hz	Follows video
Facsimile (slow-scan) channel	1 – duplex	300 to 3,500 Hz	Controlled by Class b/c
Teleprinter channel[2]	1 – duplex	300 baud	None, dedicated channel
Telemetry channel[3]	1 – duplex	0 to 500 Hz	Controlled by Class b/c
Camera control tones	6 – duplex	50 Hz each	Follows video
Signaling tones	duplex single frequency tones	share administrative voice channel	Locally generated

[1]SECAM 60 color encoding with subcarrier at 4.43 MHz.

[2]Teleprinter/keyboard service is always "on line" with the computer center.

[3]Local switching or patching shall determine which type of physiological data is to be transmitted. Selection will be one of three possibilities: electrocardiogram (ECG); lung function signals (spirogram); or electronic stethoscope (heart sounds, etc.).

Between Class "b" and Class "c" stations the same communication services shall be provided as listed above. Switching control will rest with the Class "c" stations in this case. The normal referral pattern shall hold in that the Class "c" station(s) ultimately used by various Class "a" stations shall be capable of switching referrals through from that level as well as from the Class "b" level.

2.7.5 Communication Services, Class "a" Stations

At each of the local field health stations, the following services, abstracted from the previous list, shall be available. Switching for appropriate routing, where required, is indicated.

Administrative Voice Channel (AdVC)

Each Class "a" station field health stations shall have a dedicated private line voice circuit to its associated Class "b" station. Signaling (ringing) will be possible from either end by the use of push button control of tones. Contractor shall provide parallel light and alarm where indicated in the site and floor plan drawings. This channel will be used by the field health stations to contact the peripheral hospitals for such purposes as to solicit information (voice consultation) and to set up other levels of communication links. Conferencing by push button control shall be possible at each Class "b" station for all Administrative Voice Channels terminating therein. At each station where an existing VHF radio system is available, a patchcord arrangement will be provided between the radio system and the AdVC panel.

Video Channel

Should a Class "a" station desire to consult with its associated Class "b" station in a video mode the Class "a" station would advise the Class "b" station by using the Administrative Voice Channel. Should the signal path be available at that time, the Class "b" station will actuate the appropriate remote switches to set up a duplex link. If the Class "b" station is busy and a channel is not available the Class "b" station can advise the Class "a" station via the Administrative Voice Channel as to the availability of the signal path.

Program Voice Channel

This channel of high quality sound is associated with the video channel. This high quality voice channel is switched concurrently with the video channel to automatically parallel the route of the video.

Camera Control Tones

These control tones are used for positioning the cameras from distant locations. For example, the camera at Bylas field health station shall be capable of being controlled by an operator (or a physician) located at San Carlos. Camera functions controlled would include tilt, pan, focus, zoom and iris. In all, six functions will be possible for simultaneous remote control. The sixth tone shall actuate a monochrome bypass switch in the color camera chain. These tones shall be switched en masse and concurrently with the video to parallel that route.

Slow Scan TV/Facsimile Channel

Should a Class "a" station desire to exchange "hard copy" diagrams, charts or printed matter with its associated Class "b" peripheral hospital, the Administrative Voice Channel will be used to arrange for it. Again, the Class "b" station will remotely actuate the required switches. This service is switched independently of any other communication level. All stations shall be provided with a slow-scan television send and receive device. Certain stations shall be provided with a business facsimile transceiver as detailed in specific segment documents.

Teleprinter Channel

This channel does not require switching. Each station shall have a dedicated duplex circuit back to the central computer in Tucson.

Telemetry Channel/Electronic Stethoscope Channel

Requests for routing of this channel shall be made by the Class "a" stations over the Administrative Voice Channels. Control of the actual switching shall rest with the appropriate Class "b" station and shall be independent of other services.

2.7.6 **Communication Services, Class "b" Stations**

The following services shall be provided at each peripheral hospital (Class "b" station).

Administrative Voice Channels (AdVC)

As mentioned earlier, this channel is, in the case of each Class "a" station, a dedicated line back to its associated Class "b" station. Each line termination must be available for access at the Class "b" station. Likewise, at the Class "b" station, signaling tones shall be applied to each line, individually, for the purpose of "ringing" each Class "a" station. These same circuits shall be used by the Class "b" station to transmit the necessary touch-tone signals used for control of remote switches.

An additional Administrative Voice Channel (or two in the cases where optional Class "c" stations exist) will be used for direct communication with the associated Class "c" station. Again, this dedicated circuit will be used for voice consultation and switching coordination in the routing of signals to the "c" level.

Remote lights and audible alarms are required to parallel the local console alarm at some sites. Refer to the drawings.

Conferencing shall be possible between all circuits terminating at the Class "b" stations and shall be controlled by push buttons on the AdVC panel.

In the course of seeking a voice level consultation, a remote station may not find the appropriate specialist to be in the immediate vicinity of the telemedicine room. Therefore, the referral centers' (Class "b" and "c" stations) console operators shall be provided with means whereby incoming and outgoing Administrative Voice Channel service can be extended via the local PABX (Private Automatic Business Exchange). The extension of the AdVC Service should not be limited to the confines dictated by the local PABX telephone system.

In a like manner, means should be provided for the extension of AdVC service over existing VHF radio systems. For this extension, a simple four-wire patchcord arrangement will suffice. Since a console operator will be present during those times when the VHF extension service is needed, the push-to-talk operation of the VHF radio may be retained.

Video Channel

The appropriate switching where necessary to route a desired Class "a" station video signal into the associated Class "b" station is done remotely. For example, when Phoenix, a Class "c" station, is not interacting with either San Carlos or Bylas, the switches for connecting San Carlos with Bylas are controlled by San Carlos.

Should it be desired by the Class "b" to refer one of its Class "a" inquiries on to the associated Class "c" station, it shall be capable of requesting such a configuration by contacting the Class "c" station on the AdVC. Switching of the video in these cases shall be controlled by the Class "c" station(s).

Program Voice Channel/Camera Control Tones

Both of these services are switched concurrently with and parallel to the video, discussed above.

Slow-Scan TV/Facsimile Channel

Routing of these channels is independent of any other service, however, coordination and switching control is analogous to the video plan described above.

Teleprinter Channel

Each Class "b" network station will have a dedicated duplex teleprinter circuit provided.

All teleprinter circuits will have as their final destination, the HIS computer service at Tucson. A leased telephone line (or lines) will interconnect the microwave terminal at San Xavier with the computer facility.

Telemetry Channel/Electronic Stethoscope Channel

Again, control and coordination is similar to that provided for video route switching. Routing is independent of all other services.

2.7.7 Communication Services, Class "c" Stations

The Class "c" stations are the sites having the greatest concentration of specialized skills in the Arizona TeleMedicine Network. Class "c" stations may directly communicate with other Class "c" and their associated Class "b" stations. Class "c" stations may also communicate indirectly with all other Class "b" and Class "a" stations by requesting the appropriate route switching that may be needed but is not controlled by the Class "c" station in question.

From the standpoint of a typical Class "c" station (major medical center), the levels of service and switching availabilities are as follows:

Administrative Voice Channel

Class "c" stations will have the capability of selecting one from the several dedicated voice circuits available at each site. These circuits will provide for direct communication to each of the other Class "c" stations in the network, to the Class "b" stations associated with the Class "c" in question, and those Class "a" stations which report directly to the Class "c" station. The method of extending the AdVC discussed in Section 2.7.6 via telephone and radio (where available) shall be provided at each Class "c" station.

The administrative voice channels will also carry the necessary switching tones generated by the Class "c" station in conjunction with the control of those remote switching points under the station's jurisdiction.

Video Channel – Program Voice Channel – Camera Control Tones

These three related services are, as in the arrangement for Class "a" and Class "b" stations, switched in tandem.

Slow-Scan TV/Facsimile Channel

This service is switched independently of all other services.

Teleprinter Channel

This service is not switched and is always available to all classes of stations.

Telemetry Channel/Electronic Stethoscope Channel

This service is, as with all classes of stations, switched independent of any other communication service.

2.7.8 Control of Signal Routing

Will be discussed in each appropriate segment specification.

2.8 Control Console Equipment

2.8.1 General

The control console for each terminal station in the Arizona TeleMedicine Network is indicated in each floor plan layout. This unit will serve as the operator's desk and will provide additional rack space for the modulating, demodulating and signaling equipment. Figure 2.1 is an artist's sketch of a typical control console as would be encountered at a Class "b" station. The top view of this typical console is shown as Figure 2.2.

While each station will involve some "customizing" of this design, the basic features and panel configurations will not change. The following sections of this document define the aspects of the console that are common to all sites and, also, define the differences in panels and arrangements existing between each individual site. Contractor is cautioned to recognize the size constraint of the 60- by 30-inch console.

2.8.2 Console Utilization

Listed below are the functions and panel space allocations associated with the control consoles. Those items which involve 'custom' changes from site to site are indicated and noted where appropriate. For additional clarification of panel locations, refer to Figures 2.1 and 2.2. Also, see Figure 2.3, which is a functional block diagram of a typical network station.

Twin 9-Inch Monochrome Monitors – located top, center.

Monitor Feed Select Push Buttons – located top, center near monitors. These buttons select the feed for the twin 9-inch monitors and the associated room size monitors which parallel them.

Audio Monitor Level Control and Speaker – located on upper, right panel. This unit provides program audio as it arrives with the desired incoming picture. Additionally, a switch will permit selection of outgoing programs or video tape sound. Use of the headset shall automatically defeat the loud speaker.

Handset (Administrative Voice Channel) – located on right side of desk top, connector in knee hole of desk. Extra long coil cord (15 feet) required.

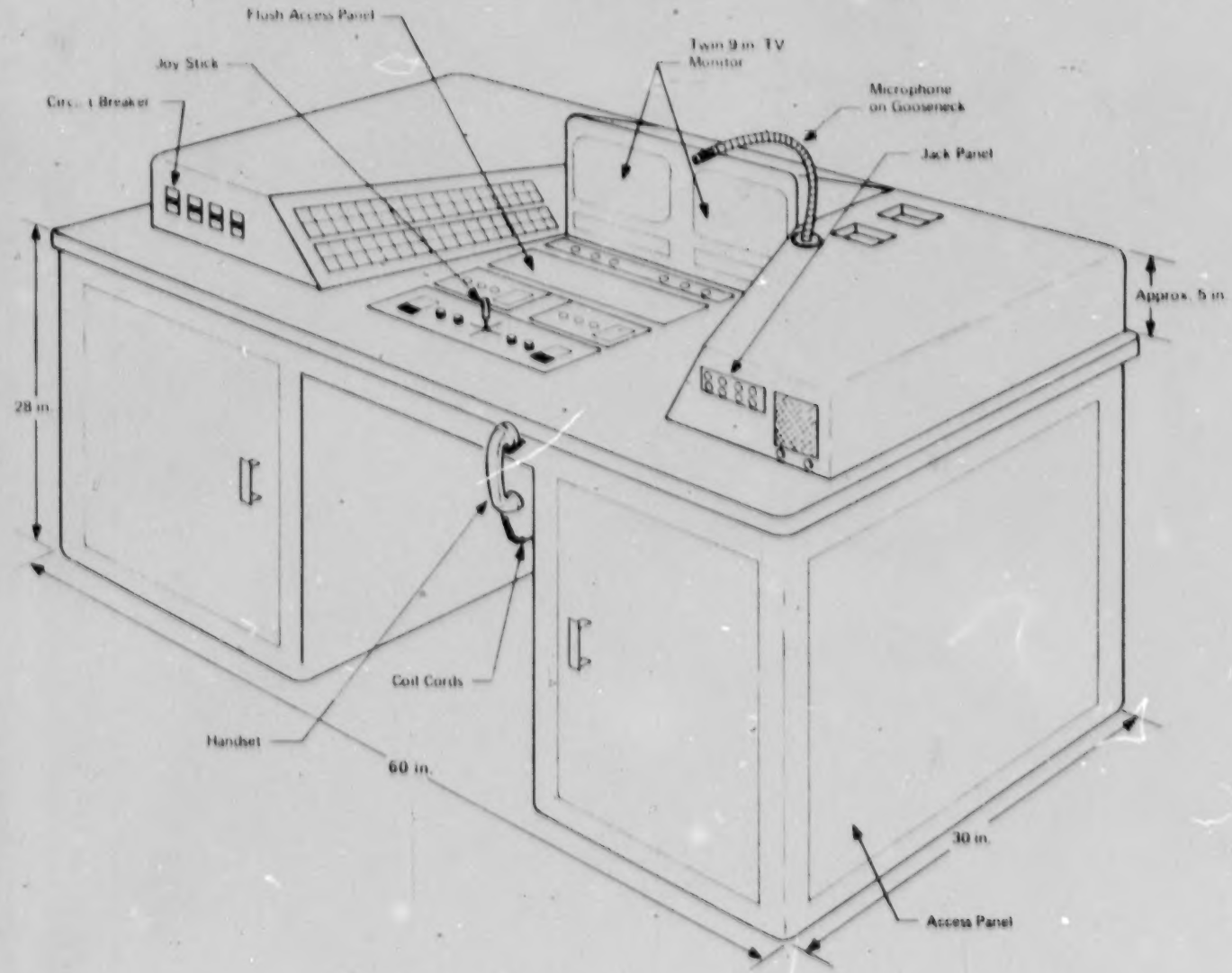


Figure 2.1. Typical Control Console.

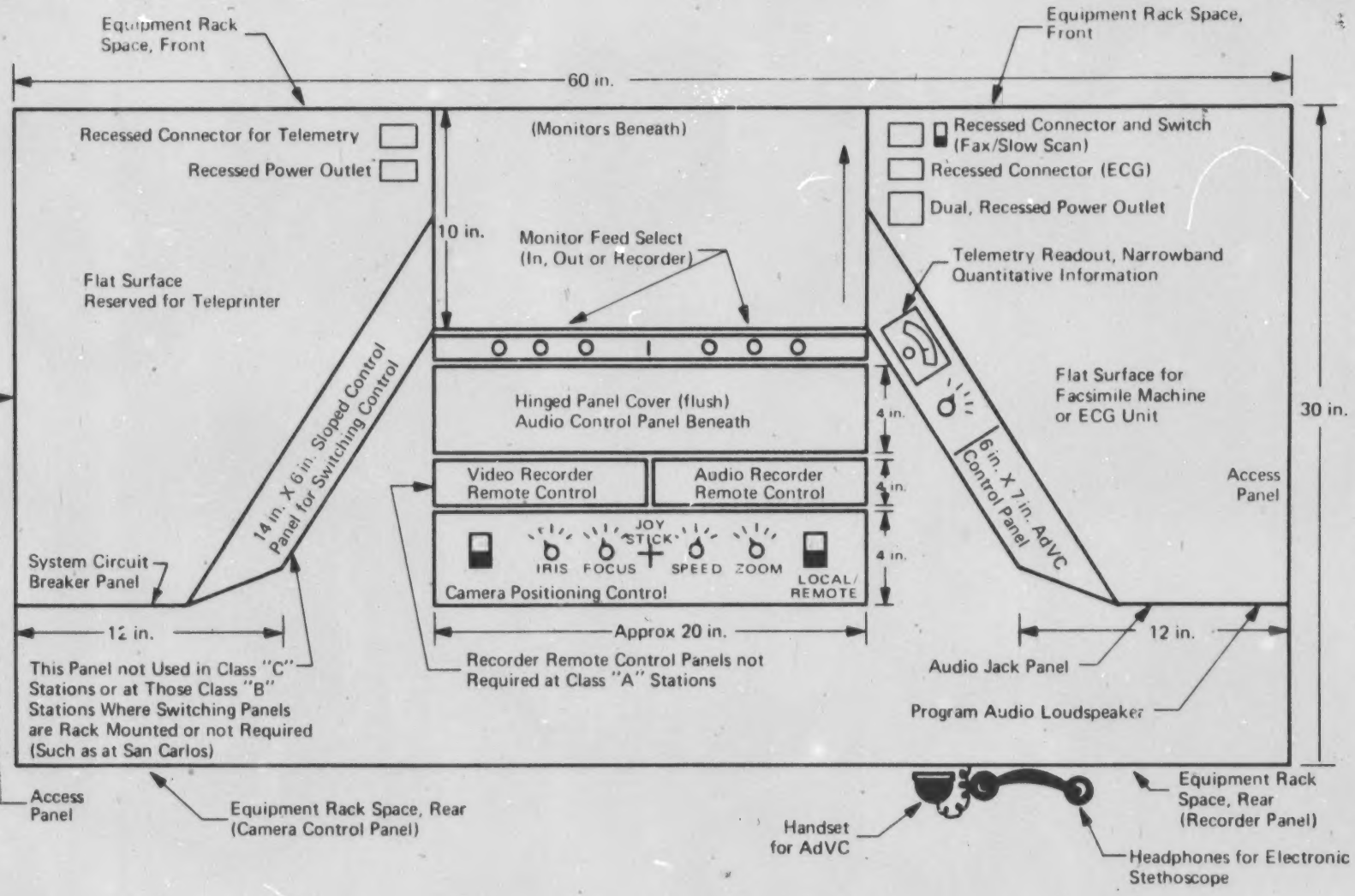
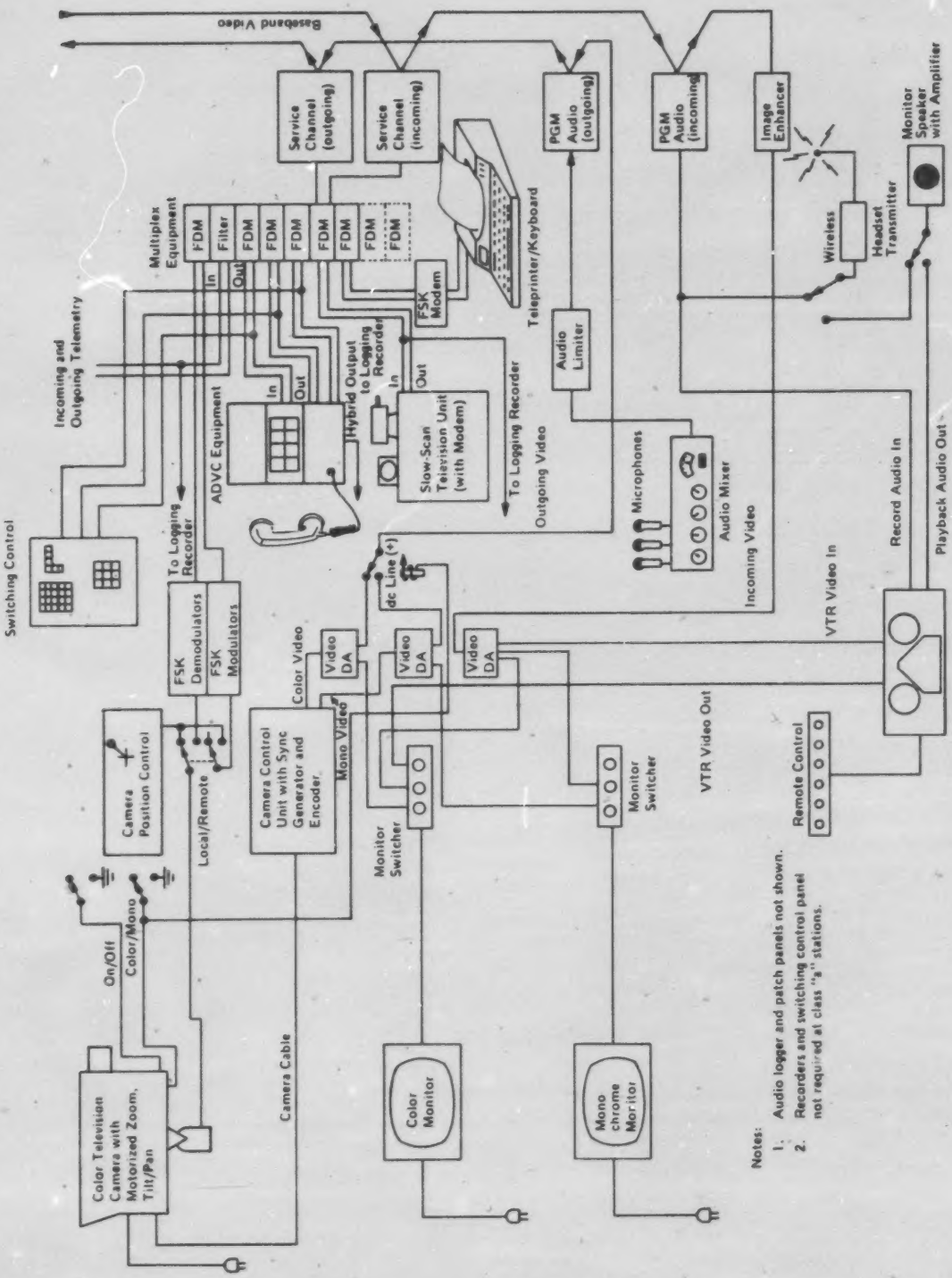

Equipment Rack Space, Front
60 in.
Equipment Rack Space, Front
Recessed Connector for Telemetry
Recessed Power Outlet
(Monitors Beneath)
10 in.
Monitor Feed Select (In, Out or Recorder)
Recessed Connector and Switch (Fax/Slow Scan)
Recessed Connector (ECG)
Dual, Recessed Power Outlet
Telemetry Readout, Narrowband Quantitative Information
Flat Surface Reserved for Teleprinter
14 in. X 6 in. Sloped Control Panel for Switching Control
Hinged Panel Cover (flush) Audio Control Panel Beneath
4 in.
Flat Surface for Facsimile Machine or ECG Unit
6 in. X 7 in. AdVC Control Panel
30 in.
Video Recorder Remote Control
Audio Recorder Remote Control
4 in.
Access Panel
JOY STICK
IRIS FOCUS SPEED ZOOM
LOCAL/ REMOTE
Camera Positioning Control
4 in.
System Circuit Breaker Panel
12 in.
Approx 20 in.
12 in.
This Panel not Used in Class "C" Stations or at Those Class "B" Stations Where Switching Panels are Rack Mounted or not Required (Such as at San Carlos)
Recorder Remote Control Panels not Required at Class "A" Stations
Audio Jack Panel
Program Audio Loudspeaker
Access Panel
Equipment Rack Space, Rear (Camera Control Panel)
Handset for AdVC
Equipment Rack Space, Rear (Recorder Panel)
Headphones for Electronic Stethoscope

Figure 2.2. Console, Top View.



Notes:

1. Audio logger and patch panels not shown.
2. Recorders and switching control panel not required at class "a" stations.

Figure 2.3. Functional Block Diagram, Typical Class "b" Station.

Audio Channel Select and Signaling Buttons, AdVC – located on right side of the sloping control board, upper right panel. The precise configuration of the push buttons on this panel will vary depending on the site involved. In all cases the audio channel select, telephone interconnect, and signaling positions will consist of 1- by 1-inch illuminated buttons. The top button in each position will flash and a common audible alarm will sound when a "ringing" signal is received via the associated Administrative Voice Channel (AdVC). This alarm will be paralleled for remote indications as needed. The flashing light and tone will continue until this button is depressed and the handset is connected. The middle button in each vertical row is used to signal the station associated with that particular AdVC. Signal tones are generated only as long as the button is depressed. At stations where more than one position appears on the AdVC panel (Class "b" or "c" stations), the upper button may be depressed twice to achieve a "conference configuration" with all stations appearing on the panel. Disconnect is effected by depressing the button still a third time. The bottom button will effect cross connect with the telephone line provided at each "b" and "c" station.

Recorder Remote Control Panels – located top, center. These panels are not required for those consoles installed at Class "a" stations. In each case, controls consist of "record," "play," "fast forward," "rewind," and "stop." Status lights shall be provided for each panel to indicate "record on" and "record off."

Audio Mixer Panel – located top, center of the console, beneath a hinged panel. This mixer shall provide a minimum of three simultaneous low level (microphone) inputs and one high level (video tape audio) input plus switched input capacity (high level) of an additional four channels (audio logger).

Recorders (one four-track audio and one single-track television recorder) – located in lower, right rack at the rear of the console. Recorders are only to be installed at Class "c" and Class "b" stations.

Telemetry Display – this unit is to be located on the sloped panel, right upper portion of the console. Only Class "b" and "c" stations will incorporate this unit which provides a real-time meter face readout for lung function tests or other information being viewed.

Camera Joy Stick and Local/Remote Switch – located top, center. In addition to the joy stick which controls tilt and pan, switches are to be provided for zoom, focus, iris and mono/color. The mono/color switch will control bypass circuitry in the color camera (local or

remote) such that a direct monochrome video feed may be shunted to the camera output. This bypass circuitry should involve only the "green gun" of the camera, prior to bandpass shaping, electronic filtering or matrixing. Resolution shall exceed 600 television lines when the bypass is activated.

When the local/remote switch on the control panel is in the remote position, the panel controls will be disengaged from the local servo motors. These motors will then respond to control tones arriving via the microwave system. Simultaneously, the panel controls will be so connected as to produce tones on the outgoing microwave channel for control of a remote camera.

Electronic Stethoscope Headset – to be hung on the right side of the desk top. This headset may be either used for its prime purpose or connected, via the patch panel, to the program channel for private listening. (See earlier discussion on audio monitor level control and speaker.)

Microphone Connectors – to be located at the upper rear of the console knee hole in a recessed panel. In addition to the fixed console microphone there will be provided two lavalier microphones available for use at each site.

Switching Panel – located for most Class "b" stations on the left-hand, sloping panel on top of the console. This panel, whether located on the console or adjacent to it, controls the local and remote switching for television, slow-scan TV, and telemetry. This panel is blank for Class "a" stations.

Circuit Breakers – located on the upper, left panel. These breakers, each of an appropriate value, will act as power switches to control various sections of the console apparatus. Individual breakers will be associated with the following: studio lights, monitors, camera, teleprinter, facsimile/slow-scan, and all other units in aggregate. A master breaker will also be supplied.

Camera Control – located at lower left of console. This unit is used for "technical setup of the camera" (optional, depending on type of camera used).

Rack Mounted Equipment – at Class "b" and Class "c" stations the front lower sections of the console are allocated to rack equipment. Class "a" stations utilize the rear, lower right area for rack equipment since recorders are not planned for these stations.

Audio Jack Panel – located on the upper right panel, adjacent to the program channel loud speaker. Input/output high level positions will be provided for: telemetry channel, program audio, electronic stethoscope and one spare. The facsimile channel may be used as an auxiliary voice return in lecture programming (a grand round).

2.8.3 Console Cable Connections

The console shall not be permanently positioned within each room. This requirement is set forth in order to permit maintenance to be accomplished without the need to dismount many units for access to those sections located interior to the console. For this reason, telemetry, slow-scan TV, power cables, coaxial cable, and other signal wires are to connect to the console by way of flexible sections and multiple pin connectors.

2.8.4 Administrative Voice Channel Selection and Signaling Panels

The configurations of the AdVC panels at each station are shown in the appropriate segment document.

All push buttons shall be 1 inch by 1 inch (nominal), rear illuminated, and marked as indicated.

2.8.5 Switching Panels

The required configurations of the television, telemetry and slow-scan TV switching control panels located at each station are described in the appropriate segment documents.

2.8.6 Elapsed Time Meters (not shown on drawings)

At all classes of terminal stations, a separate digital readout meter shall be provided for color TV, monochrome TV, slow-scan TV, Telemetry and Administrative Voice Channel. These meters shall record the accumulated usage of each service mentioned in hours and minutes. The meters shall have a range of at least 1,000 hours and be resettable.

2.9 Communications Equipment Licensing

Licensing of the microwave radio stations in the Arizona TeleMedicine System shall be in accordance with Part 91 of the Rules and Regulations of the Federal Communications Commission (FCC). Part 91 covers that part of the rules dealing with the "Business Radio Service." The licensee shall be the Board of Regents of the State of Arizona.

Preparation and filing of all radio license applications shall be the responsibility of the Contractor. The Contractor shall also provide such legal assistance in this matter as is required to obtain all necessary licenses and construction permits short of legal assistance in hearings and trials. The Contractor's attorney shall be a member of the bar in the District of Columbia; shall have at least two years of experience in communications law; and shall have participated in proceedings before the Federal Communications Commission prior to any such actions for the Arizona TeleMedicine Network.

It shall be the responsibility of the Contractor to secure two adjacent 10 MHz channels for each link in the Arizona TeleMedicine Network that demands allocation in the 6525 to 6875 MHz band. This will be the case for all links involving a path length of greater than 22 miles. Since the network will require at least 20 MHz of RF bandwidth for each link, and since the 6525 to 6875 MHz band is limited to 10 MHz channel spacing, the double channel format shall be used.

All other links shall be licensed in the 12,200 to 12,700 MHz band.

2.10 Radio Frequency Channel Assignments

It shall be the responsibility of the Contractor to conduct a careful search for frequencies to be used in the Arizona TeleMedicine Network. From this search, the Contractor shall develop a frequency plan which shall be submitted to the Project Director for his approval prior to the preparation and submission of license applications to the Federal Communications Commission.

The Contractor's microwave frequency plan shall be in accordance with FCC Rules and Regulations, shall take into account the network's 20 MHz RF bandwidth requirement and shall be compatible with all other microwave systems operating on the same or adjacent frequencies.

The frequency plan presented in Table 2.1 is set forth purely as information to the Contractor. The Contractor's own frequency plan does not necessarily have to agree with this plan. The Contractor is cautioned to make his own independent frequency search in order to ascertain availabilities and, from this data, to develop his own frequency plan. However, any changes to this plan must be fully compatible with the entire network routing.

The path profiles and signal routing presented in segment documents also are set forth purely as information to the Contractor. The Contractor is cautioned to verify all profiles and path routing prior to construction. Any deviation from the specified routing shall be approved by the Project Director prior to construction.

Table 2.1. Network Frequency Plan.

Tucson	12510 MHz Hor. →	← 12210 MHz Hor.	San Xavier
San Xavier[a]	6675 MHz Hor. 6685 MHz Hor. →	← 6825 MHz Hor. 6835 MHz Hor.	Kitt Peak
Kitt Peak[a]	6855 MHz Ver. 6865 MHz Ver. →	← 6705 MHz Ver. 6715 MHz Ver.	Santa Rosa
Kitt Peak[a]	6795 MHz Hor. 6805 MHz Hor. →	← 6645 MHz Hor. 6655 MHz Hor.	Pisinimo
Kitt Peak[a]	6735 MHz Hor. 6745 MHz Hor. →	← 6585 MHz Hor. 6595 MHz Hor.	Sells
Phoenix	6775 MHz Ver. 6785 MHz Ver. →	← 6585 MHz Ver. 6595 MHz Ver.	Pinal Peak
Pinal Peak	12290 MHz Hor. →	← 12590 MHz Hor.	San Carlos
Pinal Peak	6705 MHz Ver. 6715 MHz Ver. →	← 6825 MHz Ver. 6835 MHz Ver.	Bylas
Pinal Peak	6655 MHz Hor. 6665 MHz Hor. →	← 6855 MHz Hor. 6865 MHz Hor	Carol Spring
Pinal Peak	6665 MHz Ver. 6675 MHz Ver. →	← 6785 MHz Ver. 6795 MHz Ver.	Mt. Lemmon
Mt. Lemmon	6585 MHz Ver. 6595 MHz Ver. →	← 6705 MHz Ver. 6715 MHz Ver.	San Xavier
Carol Spring	6815 MHz Ver. 6825 MHz Ver. →	← 6615 MHz Ver. 6625 MHz Ver.	Whiteriver
Carol Spring	6835 MHz Hor. 6845 MHz Hor. →	← 6585 MHz Hor. 6595 MHz Hor.	Cibecue
Carol Spring[a]	12210 MHz Hor. →	← 12510 MHz Hor.	Cedar Creek
Phoenix	12250 MHz Hor. →	← 12550 MHz Hor.	Shaw Butte

[a]Reserved for future expansion

Table 2.1. (continued)

Shaw Butte	6765 MHz Ver. 6775 MHz Ver. → ←	6675 MHz Ver. 6685 MHz Ver.	Mingus
Mingus	6595 MHz Hor. 6605 MHz Hor. → ←	6835 MHz Hor. 6845 MHz Hor.	Mt. Elden
Mt. Elden	6855 MHz Ver. 6865 MHz Ver. → ←	6625 MHz Ver. 6635 MHz Ver.	Graveyard Junction
Mt. Elden[a]	6815 MHz Hor. 6825 MHz Hor. → ←	6715 MHz Hor. 6725 MHz Hor.	Leupp
Leupp[a]	12290 MHz Hor. → ←	12590 MHz Hor.	Ives Mesa
Ives Mesa[a]	6615 MHz Ver. 6625 MHz Ver. → ←	6795 MHz Ver. 6805 MHz Ver.	Dilkon
Dilkon[a]	6715 MHz Ver. 6725 MHz Ver. → ←	6585 MHz Ver. 6595 MHz Ver.	Klagetoh
Klagetoh[a]	12370 MHz Hor. → ←	12670 MHz Hor,	Lower Greasewood
Klagetoh[a]	12290 MHz Hor. → ←	12590 MHz Hor.	Ganado Mesa
Klagetoh[a]	6645 MHz Hor. 6655 MHz Hor. → ←	6855 MHz Hor. 6865 MHz Hor.	Defiance Summit
Defiance Summit[a]	12630 MHz Ver. → ←	12330 MHz Ver.	Window Rock
Window Rock	12590 MHz Hor. → ←	12290 MHz Hor.	Ft. Defiance Hill
Ft. Defiance Hill	12210 MHz Ver. → ←	12510 MHz Ver.	Ft. Defiance
Ft. Defiance Hill	12290 MHz Hor. → ←	12590 MHz Hor.	Piney Hill
Piney Hill	6635 MHz Ver. 6645 MHz Ver. → ←	6815 MHz Ver. 6820 MHz Ver.	Ganado Mesa
Ganado Mesa	12530 MHz Hor. → ←	12230 MHz Hor.	Steamboat Canyon
Ganado Mesa	12570 MHz Hor. → ←	12270 MHz Hor.	Cottonwood Junction

[a]Reserved for future expansion

Table 2.1. (continued)

Cottonwood Junction	12250 MHz Hor. →	← 12250 MHz Hor.	Chinle
Chinle	6775 MHz Ver. 6785 MHz Ver. →	← 6625 MHz Ver. 6635 MHz Ver.	Yale Point
Chinle[a]	6585 MHz Hor. 6595 MHz Hor. →	← 6855 MHz Hor. 6865 MHz Hor.	Balakai Mesa
Balakai Mesa[a]	12590 MHz Hor. →	← 12290 MHz Hor.	Low Mountain Relays
Low Mountain Relays[a]	12210 MHz Hor. →	← 12510 MHz Hor.	Low Mountain
Low Mountain Relays[a]	12250 MHz Hor. →	← 12550 MHz Hor.	Pinon
Low Mountain Relays	12330 MHz Hor. →	← 12630 MHz Hor.	Keams Relays
Keams Relay	12550 MHz Hor. →	← 12250 MHz Hor.	Steamboat Canyon
Keams Relay	12590 MHz Hor. →	← 12290 MHz Hor.	Keams Canyon
Keams Relay[a]	12510 MHz Hor. →	← 12210 MHz Hor.	Oraibi Relay
Oraibi Relay[a]	12330 MHz Hor. →	← 12630 MHz Hor.	Second Mesa
Oraibi Relay[a]	12370 MHz Hor. →	← 12670 MHz Hor.	Oraibi
Oraibi Relay[a]	12290 MHz Hor. →	← 12590 MHz Hor.	Rocky Ridge
Rocky Rodge[a]	6635 MHz Hor. 6645 MHz Hor. →	← 6765 MHz Hor. 6775 MHz Hor.	Preston Mesa
Preston Mesa	12590 MHz Hor. →	← 12290 MHz Hor.	Kaibito Relay
Kaibito Relay	12630 MHz Hor. →	← 12330 MHz Hor.	Kaibito
Preston Mesa	12550 MHz Hor. →	← 12250 MHz Hor.	Graveyard Junction
Preston Mesa	6855 MHz Hor. 6865 MHz Hor. →	← 6595 MHz Hor. 6605 MHz Hor.	Shonto
Shonto	12510 MHz Hor. →	← 12210 MHz Hor.	Black Mesa
Black Mesa[a]	12290 MHz Hor. →	← 12590 MHz Hor.	Kayenta

[a] Reserved for future expansion

Table 2.1. (continued)

Black Mesa	6815 MHz Hor. 6825 MHz Hor. →	← 6685 MHz Hor. 6695 MHz Hor.	Yale Point
Yale Point[a]	6595 MHz Ver. 6605 MHz Ver. →	← 6855 MHz Ver. 6865 MHz Ver.	Rock Point
Rock Point[a]	12370 MHz Hor. →	← 12670 MHz Hor.	Totacon
Totacon[a]	12590 MHz Hor. →	← 12290 MHz Hor.	Teec Nos Pas
Yale Point[a]	12630 MHz Hor. →	← 12330 MHz Hor.	Many Farms
Yale Point	12530 MHz Hor. →	← 12230 MHz Hor.	Rough Rock
Many Farms[a]	6835 MHz Hor. 6845 MHz Hor. →	← 6665 MHz Hor. 6675 MHz Hor.	Lukachykai
Ft. Defiance Hill	12250 MHz Ver. →	← 12550 MHz Ver.	Hunters Point
Hunters Point	6835 MHz Ver. 6845 MHz Ver. →	← 6605 MHz Ver. 6615 MHz Ver.	Wallace Ranch
Wallace Ranch	6665 MHz Ver. 6675 MHz Ver. →	← 6855 MHz Ver. 6865 MHz Ver.	Greens Peak
Greens Peak	12590 MHz Ver. →	← 12290 MHz Ver.	Relay 1
Relay 1	12610 MHz Ver. →	← 12310 MHz Ver.	Relay 2
Relay 2	12550 MHz Ver. →	← 12250 MHz Ver.	Carol Spring

[a]Reserved for future expansion

The Arizona TeleMedicine Network and the University of Arizona shall accept no responsibility for difficulties or extra costs incurred by the Contractor as a result of his use of this data.

3.0 APPLICABLE DOCUMENTS

The requirements and standards set forth in the following sections shall apply to the extent that they are referenced in this specification.

Electronic Industry Association Standards

RS-158	Mechanical Considerations for Transmission Lines in Microwave Relay Applications
RS-173	Emergency Standby Power Generators and Accessories for Microwave Systems
RS-195A	Electrical and Mechanical Characteristics for Microwave Relay System Antennas and Passive Reflectors
RS-203	Microwave Transmission Systems
RS-222A	Structural Standards for Steel Antenna Towers and Antenna Supporting Structures
RS-250A	Electrical Performance Standards for Television Relay Facilities
RS-252	Baseband Characteristics of the Microwave Radio and Multiplex Equipment
TR-141	Microwave Relay Facilities for Communications
RS-232C	Interface Between Data Processing Equipment and Data Communications Equipment.

Federal Communications Commission Rules and Regulations

Part 17	Construction, Marking and Lighting of Antenna Structures
Part 91	Industrial Radio Services
Part 89	Public Safety Radio Services

Federal Aviation Regulations

Part 77	Objects Affecting Navigable Airspace
FAA Circular AC 70/7460-1B	Obstruction Lighting and Marking

Medical Instrumentation Standards

"Recommendations for Standardization of Instruments in Electrocardiography and Vectorcardiography." American Heart Association, January 1967.

4.0 TRANSMISSION PERFORMANCE REQUIREMENTS

4.1 Voice Bandwidth Channels

Each "voice slot" shall comply with the following specific sections of EIA Standard TR-141:

Section of TR-141	Subject
2.1	Telephone Channel Input and Output Impedance
2.2	Transmission Gain Stability
2.3	Telephone Channel Test Signal
2.4	Overload Level
2.5	Telephone Channel Input Power
2.6	Telephone Channel Output Power
3.2	Harmonic Distortion

In addition, all voice bandwidth channels shall meet the following specifications without the use of external equalizer circuits.

a. Amplitude-Frequency Response – Referred to the response at 1,000 Hz, the amplitude shall not exceed +1 dB or fall below -3 dB in the range of 300 to 3,000 Hz, nor exceed +1 dB outside this range.

b. Envelope Delay Distortion – The envelope delay distortion shall not exceed the following values (equivalent to C-2 conditioning):

1,000 to 2,600 Hz	500 microseconds
600 to 2,600 Hz	1,500 microseconds
500 to 2,800 Hz	3,000 microseconds

c. Worst Channel Noise – Worst voice bandwidth channel noise shall not exceed the following values:

Circuit Length (miles)	Worst Channel Noise (dBrnCO)
0 – 50	35
51 – 100	36
101 – 200	38
201 – 400	40
401 – 1,000	42

d. Frequency Displacement – As defined in Section 3.3.1 of TR-141, frequency displacement shall not exceed 2 Hz.

e. Phase Jitter – shall not exceed 2 percent.

4.2 Television Channels

The wideband color television channel and its associated aural program channel as measured between any two terminasl shall comply with EIA Standard RS-250-A. The specific sections of RS-250-A which are applicable to the system are designated as follows:

Section of RS-250-A	Subject
4.1	Input impedance
4.2	Input signal level
4.4	Output impedance
4.5	Output signal level
4.6	Polarity of the picture signal
5.1	Amplitude versus frequency characteristics
5.2	Low frequency response of the picture signal channel

Section of RS-250-A	Subject
5.4	Transient response of the picture channel
5.5	Harmonic distortion in the audio signal channel
5.6	Differential gain and differential phase of the picture signal channel
5.7	Signal-to-noise ratio
5.8	Signal-to-hum ratio in the picture signal channel
5.9	Signal-to-interfering tone ratio in the picture signal channel

4.3 Telemetry Channel

The telemetry channel for the physiological signals shall be one of the 4 kHz bandwidth slots of the voice bandwidth multiplex channels. The frequency allocation is between 20 and 24 kHz. The center carrier frequency of the telemetry channel shall be 22 kHz. This frequency modulated carrier system shall have a bandwidth of 500 Hz. The placement of this carrier at 22 kHz shall not degrade the adjacent or other channels within the multiplex system such that the specifications as stated in Section 4.0, Voice Bandwidth Channels, cannot be met. Performance requirements of the telemetry channel are stated in Sections 5.11.1 and 5.11.4, FM Modulator and FM Demodulator, respectively.

5.0 EQUIPMENT PERFORMANCE REQUIREMENTS

5.1 Video Performance

5.1.1 Color Standards

Although it is planned that SECAM color[1] will be used primarily on the Arizona TeleMedicine Network, all performance characteristics of transmission equipment and common console equipment shall meet or exceed all EIA and FCC broadcast standards and recommendations for NTSC television.

5.1.2 Camera and Associated Equipment

The cameras provided as part of this system shall be of identical type and model at each terminal site (Class "a," "b," and "c" stations). The following specifications shall apply to the camera and associated components.

1. The camera shall weigh no more than 45 pounds including the weight of the lens and view finder but excluding the weight of the mount, cradle head and motor driven tilt/pan head.

2. The camera chain shall provide broadcast quality color television images and shall be completely solid state except for the image tubes.

3. The view finder shall be easily removed.

4. The camera shall utilize three lead oxide pickup tubes. The tubes, arranged in a standard RGB configuration, shall be of separate mesh type.

5. An electrically operated zoom lens (focus, iris, zoom) with local and remote controls shall be supplied. The lens shall have a range of 10 to 1 (15 mm to 150 mm) with a maximum iris opening of at least f/2.8. A prealigned and sealed color optical system shall be employed interior to the camera.

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[1] 525 line, 30 frames, color subcarrier at 4.43 MHz.

page 4-4 is blank

6. The camera shall be modified so as to provide automatic, remote selection from the control console of either the encoded color output or the monochrome output. The monochrome output bypass shall select the video signal prior to bandpass limiting.

7. The color encoder shall provide SECAM-60 color television as its output. Color subcarrier shall reside at 4.43 MHz.

8. Individual channel aperture compensation shall be provided.

9. Geometric distortion (not including lens effects) shall be not greater than ±1 percent.

10. Intercom connectors, amplifiers, and wire pairs shall be provided.

11. Signal-to-noise ratio shall not be less than 40 dB at 25 foot-lamberts scene illumination.

12. Signal-to-noise ratio shall not be less than 50 dB at 50 foot-lamberts scene illumination.

13. For ease of maintenance, all circuit boards and integrated circuits shall be of the plug-in type.

14. Output level: one volt peak-to-peak composite signal.

15. Resolution: not less than 400 lines, center with aperture correction when camera is in the color mode of operation. When the monochrome bypass is actuated, resolution shall not be less than 600 lines center. Modulation transfer at these limits shall be at least 30 percent.

16. There shall be supplied at each terminal site (Class "a," "b" and "c" stations) a permanent wall or ceiling mounted bracket for the support of the camera, lens and tilt/pan unit. The bracket and its installation shall be rigid and shall not create noticeable optical jitter in the television image due to normal vibrations in or near the telemedicine room.

17. As an alternate portable camera support, a dolly/pedestal/cradle head shall be provided at each site. Manufacturer's specifications as to recommended weight handling capacity of the dolly/pedestal/cradle head shall exceed the total weight of the view finder, camera, lens and motorized tilt/pan head by at least 15 percent.

As part of his camera equipment supplied as a part of this network, the Contractor shall provide a 10-foot and a 50-foot extension cable for each Class "a" and Class "b" site. These cables shall have the proper fittings and connectors to allow for connection between the camera control console and the camera head.

The cable thus supplied shall contain, in addition to the camera related conductors, a program audio circuit and an intercom circuit. The program audio circuit shall be electrically equivalent to the microphone cords supplied as part of the audio facilities at each site.

5.1.3 Television Monitors

General

Throughout the Arizona TeleMedicine Network there shall be installed at each terminal site (Class "a," "b" and "c" stations), a system-wide standard complement of monitors. As an integral part of the control console there shall be supplied a twin 9-inch (diagonal) monochrome monitor panel. In the following specifications this dual monitor shall be referred to as the "console video monitors." In addition to the console video monitors, the Contractor shall supply a single large screen color video monitor (termed "color monitor" throughout these specifications) and a single large screen monochrome ("black and white") monitor.

Console Video Monitors

1. Console video monitors shall be constructed so as to present two complete but separate side-by-side monitors in a single panel suitable for mounting in a 19-inch equipment rack.

2. Console video monitors shall be capable of presenting a monochrome image of 600 line center and corner resolution without geometric distortion greater than 3 percent of picture height.

3. With the exception of the high voltage rectifier and kinescope, the monitor is to employ all solid state construction.

4. Video response shall be 10 MHz ± 1 dB.

5. Input impedance shall be high impedance or 75 ohms (switchable).

6. DC restoration (sync tip clamp) shall be provided and switchable in or out.

7. Video signal input, composite, shall be 1 volt peak-to-peak ±50 percent with all specifications met.

Black and White Monitor

1. The large screen black and white (monochrome) monitor provided at each site shall be of the cabinet type suitable for either shelf mounting or for mounting using a ceiling supported yoke or pedestal.

2. Screen size shall be 17 inches.

3. With the exception of the kinescope and high voltage regulator, the monitor shall employ all solid state construction.

4. Linearity shall be within 3 percent of picture height.

5. Resolution shall be in excess of 600 lines, center and corners.

6. Video response shall be flat within 1 dB to 10 MHz.

7. Input impedance shall be switchable to either high impedance or 75 ohms.

8. DC restoration (sync tip clamp) shall be provided as a switchable option.

9. Video signal input level, composite, shall be 1 volt peak-to-peak ±50 percent with all specifications met.

Color Monitors

1. The color monitor provided at each site shall produce full color pictures from SECAM-60 encoded color video signals with a color subcarrier center frequency of 4.43 MHz.

2. Screen size shall be 17 inches.

3. Kinescope shall be of the "trinitron" type.

4. The monitor shall be all solid state with the exception of the high voltage rectifier and kinescope.

5. Video band pass flat to 4.43 MHz, ±1 dB.

6. Linearity shall be within ±2 percent of picture height.

7. DC restoration shall be provided as a switchable option.

8. Video input impedance shall be switchable from high impedance to 75 ohms.

9. Video signal input level shall be 1 volt peak-to-peak ±50 percent with all specifications met.

5.2 Magnetic Tape Recorders and Playback Units

5.2.1 General

There shall be supplied, as a part of each control console at each Class "b" and each Class "c" station, two record/playback units. One unit, referred to in the following specifications as "video cassette playback/record unit" shall provide a means of logging the television transmissions received by each station where it is installed. It shall simultaneously record both sides of the associated program audio (send and receive). The other unit shall simultaneously log both sides of the exchange transmissions of telemetry and slow-scan TV. Four channels of voice grade audio are therefore required. This unit is referred to, below, as the "audio channel logger."

All units supplied of each type shall be identical in model and manufacturer.

5.2.2 Video Cassette Playback/Record Unit

1. This unit shall be completely self-contained with dimensions not to exceed 18 X 20 X 10 inches.

2. Recording tracks shall include two audio channels and one video channel.

3. Format shall be helical scan, full field, employing tape having a width of not less than 1/2 inch.

4. Video response shall be at least to 5 MHz ± 2 dB.

5. The unit shall accept cassettes having a playing time of at least 60 minutes.

6. Audio response shall be flat 75 Hz to at least 10 MHz ±1 dB.

7. Each unit shall be supplied with 20 blank cassettes each with a playing time of 60 minutes.

8. Video signal-to-noise ratio shall be greater than 40 dB.

9. Resolution shall be at least 250 lines.

10. Provision for remote control of "play," "record," "fast forward," "rewind" and "stop" shall be available. Indicator lamps to show recorder status (off, red; on, green) shall be provided.

5.2.3 Audio Channel Logger

1. This unit shall be no larger than 18 X 12 X 10 inches and shall be designed to be mounted in a standard 19-inch equipment rack.

2. Four simultaneous audio tracks are to be provided so as to allow for the concurrent logging of incoming and outgoing slow-scan TV transmissions and incoming and outgoing telemetry transmissions.

3. The format shall involve either cartridge or cassette packaging, at the Contractor's option. Reel-to-reel machines are not acceptable.

4. Each audio track (channel) shall reproduce a band of frequencies from 100 Hz to 4 kHz with a flat response (±2 dB).

5. Signal-to-noise ratio shall not be less than 36 dB.

6. Tape speed shall not vary from its design specification more than 1 percent in the short term (8 hours). Total harmonic distortion shall not exceed 1 percent.

7. Provision shall be made for remote control of "play," "record," "fast forward," "rewind" and "stop." Indicator lamps as provided for the video recorder shall also be included for the audio logger as well.

8. Outputs from this unit shall be provided on the audio jack panel on the main control console.

5.3 Switcher Matrices

5.3.1 General

These units, known as "video switchers" and "audio switchers" in the specifications that follow, are to be located at those points throughout the Arizona TeleMedicine Network where more than two duplex links come together and require to be routed on the several independent communication "levels" that are provided. The video switchers must switch both the wideband color video and its associated sound. The audio switchers are those matrices associated with telemetry routing and slow-scan TV routing.

All units provided in this category shall use interchangeable modules and be expandable to at least a 12 X 12 capacity.

5.3.2 Video Switchers

1. These units shall be all solid-state, self-contained utilizing modular construction.

2. Frequency response shall be flat within 0.5 dB to 5.5 MHz.

3. Cross-talk, worst case, shall not exceed -60 dB as referenced to desired signal.

4. Hum and noise shall not exceed -55 dB, referenced to signal level rms.

5. Differential gain: ±1 percent

6. Differential phase: ±0.2 degree

7. Input and output impedance shall be 75 ohms.

5.3.3 Audio Switchers

1. These units shall be all solid-state, self-contained utilizing modular construction.

2. Frequency response shall be flat within 1 dB 50 Hz to 5 kHz.

3. Cross-talk shall not exceed -50 dB referenced to desired signal.

4. Hum and noise shall not exceed -50 dB, referenced to desired signal.

5. Total harmonic distortion shall not exceed 1 percent.

6. Input and output impedance shall be 600 ohms, balanced.

5.4 Video Amplifiers and Terminal Equipment

Loop-through monitor connections and video signal bridging will not be permitted in the construction of the Arizona TeleMedicine Network, video distribution amplifiers shall be required at all multiple feed points in the system. In addition, each station shall have in its console video line an image enhancer such as the CBS Laboratories, Inc, "Model 8000[1] Image Enhancer" or equal.

Video handling equipment not covered in the other sections of this specification shall have the following performance characteristics.

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[1] Modified by the manufacturer as required to handle SECAM-60.

1. All solid-state, modular construction.

2. All incoming video lines to each terminal site, at the console end, shall be connected to differential input distribution amplifiers with clamping circuits. Cable equalization shall be provided for runs in excess of 200 feet.

3. Frequency response shall be flat (±1 dB) to 10 MHz.

4. Differential gain shall be less than 0.5 percent.

5. Differential phase shall be less than 0.25 percent.

6. Isolation between outputs of distribution amplifiers shall be better than 35 dB.

7. Hum and noise shall be held to 55 dB or more below picture level.

5.5 Audio Equipment

This section of the specification covers that equipment associated with the main program audio channel (associated with the video).

1. Frequency response shall be flat ±2 dB from 50 Hz to 15,000 Hz.

2. Harmonic distortion shall not exceed 1.0 percent.

3. Signal-to-noise shall be greater than 50 dB.

4. Console audio mixer shall have an automatic level control (limiter amplifier) associated with it. Both units are to be entirely solid state.

5. Console audio mixer shall be capable of mixing inputs from at least 3 microphones and, in addition, shall, by way of a front switch, handle up to 4 auxiliary high level inputs in sequence.

6. Audio mixer front panel shall include a VU meter and all operating controls.

7. Included with the microphones supplied at each site shall be one fixed, directional microphone mounted on a "gooseneck" adapter as shown on the drawings of the console. In addition there shall be supplied, at each site, 2 lavier microphones with 15-foot cords and suitable connectors.

   All microphones shall be of the moving coil dynamic type. Frequency response shall be 70 to 12,000 Hz or better. Output should be low impedance, balanced.

5.6 Multiplex Channel Equipment

1. Standard frequency division multiplex equipment providing a maximum of 12 channels with 4 kHz spacing shall be supplied. The channels shall be used as four wire circuits. Modulation shall be single-sideband, suppressed carrier.

2. All channel modules shall be of the plug-in type.

3. Only those modules actually required to provide the channel service specified at each site (and recommended spares) shall be supplied.

5.7 Microwave Radio Equipment

5.7.1 General

Although it is planned that SECAM color will be used primarily on the Arizona TeleMedicine Network, all performance characteristics of transmission equipment and common console equipment used in the network should meet or exceed all EIA and FCC broadcast standards and recommendations for NTSC television, which has more stringent requirements.

Wherever possible, heterodyne repeaters should be used to maintain the highest possible standard of transmission quality. This can be done at relay sites where no switching is necessary. To render the receivers less susceptible to adjacent channel interference the Contractor shall supply microwave receivers with the minimum IF bandwidth necessary for proper reception of the associated microwave transmitter's emission.

The basic requirements listed below should be used as firm guidelines in the selection of the radio system and associated equipment.

- All equipment should be FCC type accepted
- Frequency modulation (FM) is to be used with RF bandwidths of at least 20 MHz at each station
- All circuitry, with the exception of waveguide and other microwave components, shall be in the form of subassemblies or modules that may be easily disconnected and removed
- All solid-state construction is to be favored.

Engineering specifications for the microwave radio system should be based on a design which takes into account the following guidelines of good practice.

- Microwave frequencies above 10 GHz should not be specified for hops of greater than 21 miles
- All paths should provide 3/10 first Fresnel zone clearance using an effective earth curvature of 2/3
- Calculated 6-GHz receive levels should be in excess of -34 dBm except in cases where a tunnel diode amplifier is to be employed. In these cases, a -38 dBm lower limit for calculated receive level should be used. For 12 GHz, the recommended lower limit, without TDA, is -35 dBm.

All microwave and ancillary equipment supplied by the Contractor shall meet the additional conditions and design criteria set forth below.

5.7.2 Environmental Conditions

Equipment shall be capable of operation according to these specifications under the following ambient conditions:

Temperature	0 to 45°C
Humidity	up to 90 percent RH at 40°C

Equipment shall not sustain damage from prolonged exposure, either operating or nonoperating, to ambient temperatures in the range of -20°C to 50°C.

5.7.3 Power Requirements

The equipment shall be capable of operating from 24-volt or 48-volt direct current power sources to be furnished by the Contractor. Primary power shall be from 115/230-volt, 60-Hz single-phase mains.

5.7.4 Metered Parameters

Provision shall be made for metering the following parameters by means of meters and switches and included as a part of the equipment, or by means of readily accessible test points on the front panels.

1. All power supply and bias voltages, including high voltage supplied to microwave tubes (if used).
2. Cathode or beam current of each microwave tube.
3. Rectified diode current of the receiver mixer.
4. AGC voltage of the IF amplifiers.
5. IF output level.
6. Balance of AFC discriminator.
7. Transmitter output power.
8. Local oscillator drive level to the transmit frequency changer (where possible).

Accuracy of built-in meters shall be ±3 percent of full scale deflection. Normal meter readings shall fall between 30 and 80 percent of full scale deflection.

5.7.5 Electrical Protection

Equipment shall be protected from damage due to overvoltage, undervoltage, short circuits, open circuits, and from incorrect operation of equipment controls and switches by the provision of fuses, circuit breakers, interlock circuits and similar devices. Fuses shall be clearly labeled as to function and capacity. Power circuits provided for maintenance purposes and for ancillary equipment shall be isolated from the radio equipment power circuits by separate breakers or fuses, such that a fault in maintenance or ancillary equipment will not cause a loss of power to the radio equipment. Provision shall be made by means of electrical interlocks, safety covers and similar safety devices to minimize accidental contact with conductors carrying dangerous voltages. Safety covers shall be marked with appropriate warnings, as for example, "DANGER HIGH VOLTAGE" in red, clearly legible letters.

5.7.6 Mounting

Electronic equipment shall be mounted on standard 19-inch racks not exceeding a height which can be conveniently installed in the space available.

5.7.7 Modular Design

All circuitry, with the exception of waveguide and other microwave components, shall be in the form of subassemblies or modules that may be easily disconnected and removed. Preferably, the modules shall use printed circuit card techniques. All plug-in type modules shall be removable from the front without prior need to turn off the equipment.

5.7.8 Routine Adjustment

Any adjustments required during any routine maintenance procedure, including those affecting waveguide components, shall be readily available from the front of the equipment without requiring the equipment to be first turned off and without requiring safety interlocks to be bypassed.

5.7.9 Materials

No fungus nutrient material or material subject to insect attack shall be used in the construction of equipment.

5.7.10 Component Requirements

All solid-state design is preferred. Equipment shall employ all solid-state design except that microwave tubes, such as traveling wave tubes, may be employed if necessary. All semiconductors shall comply with EIA Standards. Circuit designs that require selection of components or parts to achieve desired performance shall be prohibited. Traveling wave tubes must be of the repairable type. All components shall be protected against the effects of moisture, heat, chemical action and foreign materials such as dust and grit.

5.7.11 Marking and Finish Requirements

Each radio transmitter and receiver shall be clearly and permanently marked as to the location it transmits to or receives from. All controls, meters, switches and indicator lamps shall be clearly labeled as to function. Pin jack test points shall be color coded to indicate balanced or unbalanced circuitry. All modules and subassemblies shall be clearly labeled as to function and type number.

5.7.12 Identification of Circuit Components

The designations of each circuitry component, and its value, as referenced in the schematic diagrams, shall be marked on the circuit board adjacent to that component, whenever practical. Where there is insufficient space for legible marking, the component shall be identifiable from component layout diagrams in a maintenance manual.

5.8 Teleprinter and Associated Equipment

5.8.1 General

The digital data equipment requirement must satisfy the need to retrieve information from the computer center near San Xavier. This computer center, operated by Bell Aerospace, is used as the data source for the Health Information System of the Indian Health Service. The present terminals, with hard copy output and keyboard input, operate over voice grade lines receiving and transmitting data asynchronously at 300 bits per second (30 character/second).

Certain voice grade channels throughout the Arizona TeleMedicine Network shall be designated for two-way digital data use with each terminal site having a dedicated line to the computer center. Sites will be grouped to a maximum of 6 and will share a common voice circuit. This shall be accomplished by use of frequency shift keying transmission.

5.8.2 Information System Retrieval Terminal

The terminals provided by the Contractor shall be of the teleprinter type with a page (approximately 8-1/2 X 11) output. They shall have a standard alphanumeric typewriter keyboard with at least a 64 coded character set. Each terminal shall be capable of sending and receiving USASCII coded information at a rate of 10 and 30 characters per second and shall conform to EIA Standard RS-232 for either direct or acoustic coupling to a standard voice grade telephone circuit as an alternative to the data channel set aside for it. The acoustic coupler can be either separate or built-in the terminal. Units so provided shall be of the small portable type suitable to fit within the desk top space to be provided on the console.

5.8.3 Modems

Modems to be provided by the Contractor shall have a standard interface input (RS-232) and be compatible with standard terminals such as are presently in use (TYMESHARE 1030, GE TERMINET 300).

The modems shall employ frequency shift keying and operate asynchronously at 300 bits per second. Each site shall be assigned one of the six set of frequencies of the C.C.I.T.T. standard for frequency shift keying at the rate of 300 bits per second. The modem shall interface directly to the voice channel which shall have the characteristics of the Bell System Type 3002 data circuit with C2 conditioning. The appropriate frequency set modem shall be provided at the computer site. This modem shall interface to the Control Data Corporation model 3316 Data Communication Controller as per RS-232 requirement.

5.9 Facsimile Equipment

As a local alternate means of transmission, facsimile transceivers shall be provided at certain selected sites. These units, in each case, shall be portable and shall be equipped so as to allow their interconnection through the 4 kHz circuit normally associated with the slow-scan television unit either via an acoustical coupler or direct wire. A patch cord arrangement or switch shall be provided at each of the three sites to permit the use of either facsimile or slow-scan television as alternate modalities.

The facsimile units shall be of the "business" type with resolution of 90 lines per inch or better. Transmission time for 8-1/2- X 11-inch page shall not exceed 6 minutes. Design shall be such that minimum operator manipulation is required. The transceiver shall be capable of sending and receiving charts, prescription orders, laboratory data and the 50 millimeter electrocardiographic strip tracing.

5.10 Slow-Scan Television Equipment

Slow-scan monochrome television transceivers shall be provided at all terminal locations. Since it is desirable to preserve the resolution and grey scale, the Contractor shall utilize magnetic disc storage as the means of achieving scan conversions. Standard 525, 60 field (2:1 interlace) cameras shall be employed.

The equipment shall be capable of producing a 525 line video image with a transmission time of 120 seconds or less over a designated voice channel. It shall be capable of displaying X-ray images and shall have a horizontal resolution in excess of 500 TV lines after transmission. It shall be designed to expose and read out upon command a quality TV picture. It shall have an optical zoom feature which will allow a small area of the image to be displayed on the entire viewing area of the monitor. The monitor itself shall be compact and included as part of the slow-scan television console. The monitor devices shall have the same basic electrical characteristics as called for in connection with the control console equipment. A contrast control and switchable dc restoration shall be provided as operator controls. The slow-scan TV system shall reproduce at least 10 steps of grey.

5.11 Telemetry Channel Equipment

5.11.1 FM Modulator

A voltage controlled oscillator will be used for the telemetry of physiological signals. All signals will be sent over a single FM channel (dc-500 Hz) with appropriate filtering and conditioning before and after transmission of signals.

The equipment at the transmission end (this is a one-way system) will consist of the following:

1. Voltage controlled oscillator and line amplifier

2. Signal conditioner and filter for heart sounds

3. Signal conditioner and filter for spirometry

4. Signal conditioner and filter for ECG

5. Calibration unit

6. Switching unit

7. Power supply and mounting hardware.

This is shown in Figure 5.1.

Voltage Controlled Oscillator

Center frequency shall be IRIG standard of 22.00 kHz with proportional bandwidth deviation of ±7.5 percent for full scale.

Frequency response must be flat (±3 dB) from dc to 500 Hz.

Full bandwidth deviation must correspond to an input ±2.5 volts (peak-to-peak) adjustable input voltage offset control is desirable but not mandatory.

Input Characteristics

The input shall be single-ended and referenced to signal ground. The input impedance of the voltage-controlled oscillator shall be a minimum of 100,000 ohms shunted by less than 100 picofarads.

Stability

The center frequency shall be stable within ±0.1 percent of the nominal center frequency for 15 hours after a 15 minute warm-up, and the drift shall be less than ±0.01 percent of center frequency per degree centigrade change in the ambient temperature.

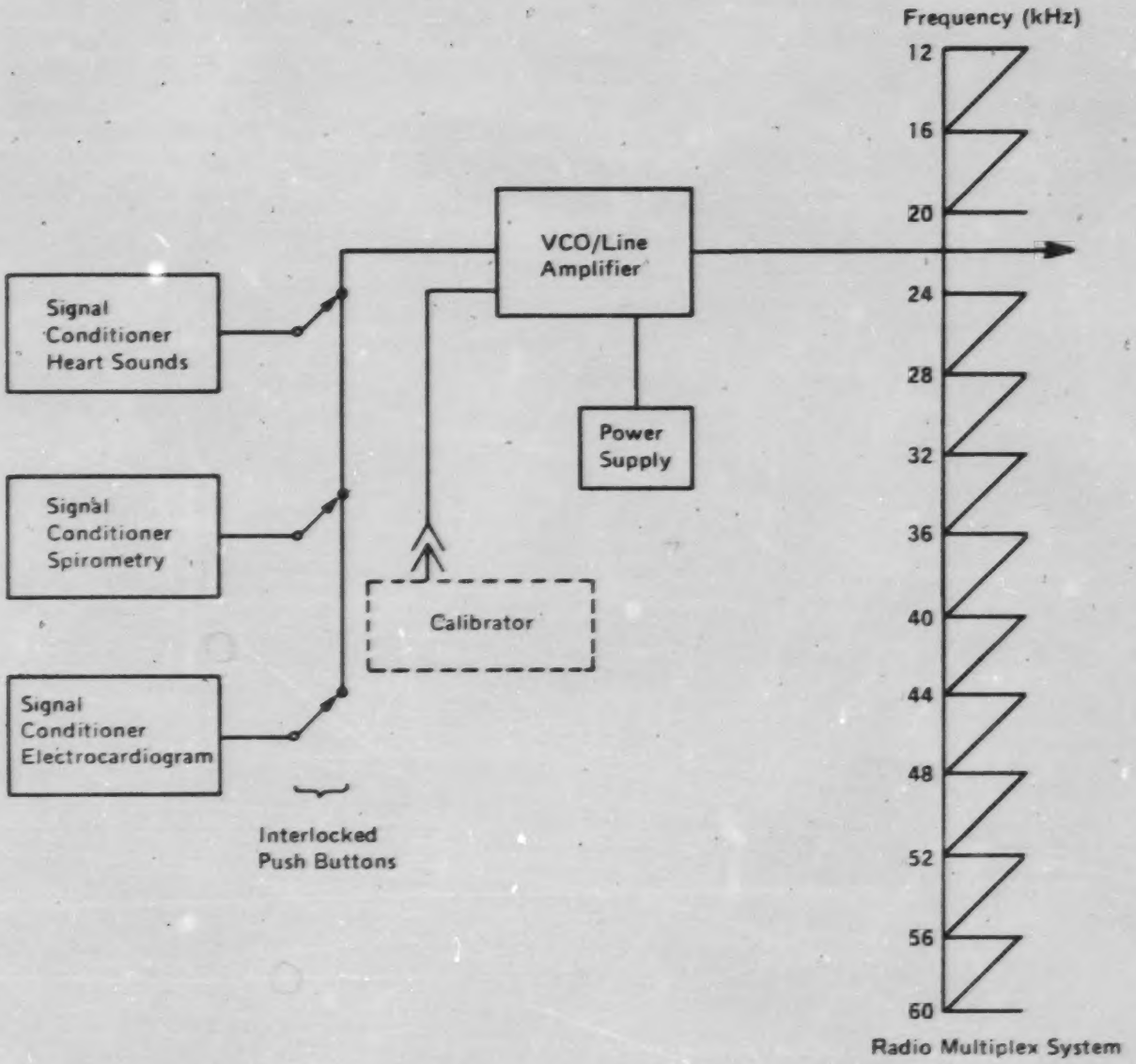

Figure 5.1. Physiological Signals Transmission System.

Linearity

The linearity of the voltage-controlled oscillator shall be within ±0.1 percent of full bandwidth, measured from the best straight line drawn between the end points.

Power Supply Requirement

The input power requirement shall be 120 volts ±10 percent, 47 to 73 Hz, single phase.

Line Voltage Stability

A 10 volt change in line voltage anywhere between 108 and 132 volts shall cause a change of less than 0.1 percent of center frequency on any unit.

Overload Recovery

If an overload voltage of up to 1,000 percent is applied for any duration and then removed (50 volts maximum) the input amplifier shall recover to within 1 percent of full bandwidth within 2.0 milliseconds.

Amplitude Modulation and Distortion

The sine wave output of the voltage-controlled oscillator shall contain less than 1 dB of amplitude modulation and less than 1 percent total harmonic distortion for deviations of ±7.5 percent or less.

Output

The output current capability is to be 10 milliamperes. The unit shall be designed so that a short circuit on the output will not damage the unit. It shall be designed to be compatible with microwave telephone multiplex equipment.

Output Noise

The voltage-controlled oscillator shall have an output noise of less than 0.4 percent of full scale over the bandwidth with the input leads shorted directly through 1,000 ohms or less.

Operating Temperature Range

The units shall operate within the above specifications within a temperature range of +10°C to +50°C circulating air.

Mounting Panel

It shall be standard EIA 19-inch rack size.

5.11.2 **Signal Conditioning for Transmission**

Heart Sounds Conditioning

This conditioner may be included with the electronic stethoscope instrumentation. Specifications for the electronic stethoscope follow.

The frequency response of the dynamic microphone and heart sound amplifier shall be from 25 to 1,000 Hz (3 dB down).

It shall have several low end filter selections which limit the low end of the band at 25, 50 and 100 Hz (3 dB down). The roll-off characteristics shall be 12 dB per octave with constant amplitude characteristic response.

The gain shall be adjustable up to at least 45 dB.

The output voltage shall be ±2.5 volts for full scale. The voltage shall be clamped at a level of 125 percent of full scale and an indicator provided so that the operator may adjust the volume to keep within range of the voltage controlled oscillator. An internal volume adjustment shall adjust the gain to the headphones so that 80 percent full-scale output voltage represents "normal" listening volume.

This output shall have the same dynamic range and frequency response as the telemetry output.

It can be either battery or line powered.

It may be incorporated into a single hand-held unit (microphone and amplifier combined) or the amplifier and controls may be a separate unit which will be mounted with other examining equipment on a movable cart.

Spirometry Conditioning

This unit shall have the amplification (attenuation), filtering and impedance requirements necessary to interface the spirometer to the common voltage controlled oscillator. This unit may be an integral part of the spirometer or a separate module mounted within the examining equipment on the movable cart.

The frequency response shall be from dc to 100 Hz (3 dB down).

The signal-to-noise ratio shall be greater than 48 dB with input shorted through a 1,000-ohm resistor.

Output must match input characteristics of voltage controlled oscillator. It shall be limited to 125 percent of full scale. The signal shall be compatible with the University of Arizona automatic spirometry program which uses a 13.5 liter spirometer for input.

Electrocardiographic Conditioning

This unit shall contain the amplification (attenuation), filtering and impedance requirements necessary to interface to the common voltage controlled oscillator.

This unit may be provided as an integral part of the electrocardiograph.

It shall accept the single-ended output signal of a standard 12 scaler lead electrocardiograph machine. This signal has a full-scale range of ±2.5 volts which represents ±2.5 millivolts at the body surface.

It shall have unity gain. It shall have a frequency cutoff at 200 Hz (3 dB down) with a constant amplitude filter response and a roll-off of 12 dB octave thereafter.

Noise shall be less than 7 millivolts rms with the input shorted through a 1,000-ohm resistor. If separate, input shall be through a BNC connector.

Output shall be ±2.5 volts to conform to the input of the voltage controlled oscillator. This output shall be limited to 125 percent of full scale.

5.11.3 Calibration and Switching Unit For Transmission

A means must be provided for readily injecting test voltages of: plus full scale, plus 1/2 full scale, zero, minus 1/2 full scale and minus full scale, and then calibrating the frequency output of the voltage controlled oscillator. Voltage source and frequency counter need not be an integral part of the telemetry instrumentation but may be part of test equipment.

Switching must be provided to switch any one of the three signal conditioning units to the voltage controlled oscillator. Switching must be such so that amplifiers or voltage controlled oscillator do not "lock up." Transients are to be controlled to within reasonable limits.

5.11.4 FM Demodulator

All signals will be received over a single FM channel via a discriminator with filtering and conditioning appropriate for the various signals.

The equipment at the receiving end consist of the following:

1. Discriminator
2. Signal conditioner and filter for heart sounds
3. Signal conditioner and filter for spirometry
4. Signal conditioner and filter for ECG
5. Calibration unit
6. Switching unit.

This is shown in Figure 5.2.

Power Switch

Each power supply unit shall be equipped with a control for applying or disconnecting primary power (120 volts ac).

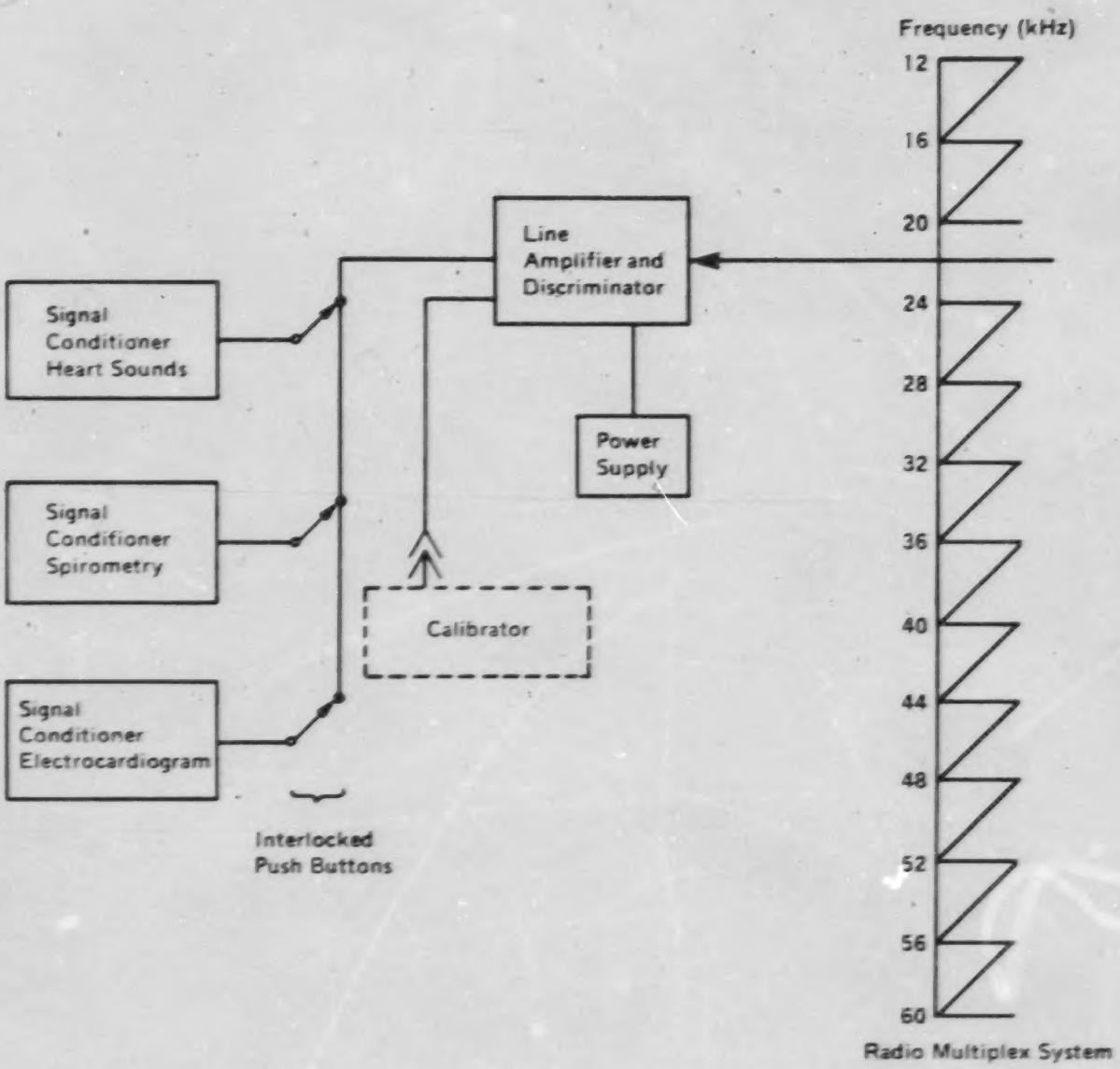

Figure 5.2. Physiological Signals Receiving System.

Discriminator Balance Control

A balance potentiometer shall be provided for each discriminator to adjust center frequency.

Data Cutoff Frequencies

The unit shall operate at data cutoff frequencies of 500 Hz.

Input Impedance

The individual unit input impedance shall be 50,000 ohms resistance minimum.

Dynamic Input Signal Range

The dynamic input signal range capability of the unit shall be at least from 50 mv to 2 volts rms (60 dB).

Amplitude-Modulation Rejection

Operation of the unit with a deviation ratio of 5, introducing a 20 dB step of input amplitude within the 60 dB dynamic input range shall not cause a peak transient of more than 1.0 percent of full bandwidth.

Adjacent Channel Rejection

Cross talk due to nearest-bandedge deviation of an adjacent ±7.5 percent deviation, IRIG channel shall be attenuated at least 60 dB where the interfering signal has an amplitude 26 dB greater than the desired subcarrier and where the desired subcarrier is anywhere within its band.

Linearity

The unit shall be capable of maintaining linearity to within ±0.25 percent of bandwidth best straight line.

Output Noise

With the unit operating a maximum bandedge output voltage, the signal-to-noise ratio shall be greater than 48 dB.

Output Zero Stability

After a 30-minute warmup, the unit shall be capable of maintaining an output zero stability to within 0.5 percent of bandwidth for deviations of ±7.5 percent providing the unit is maintained at a constant temperature over a 15-hour period.

Output Voltage

The output voltage shall be single-ended and referenced to ground. Open-circuit bandedge output voltage shall be adjustable between ±1.5 and ±10 volts. The output voltage shall be limited to 125 percent of bandedge voltage, or 13 volts, whichever is less. Deviation sensitivity shall be positive.

General Requirements

Power Supply Requirement

The input power requirement for each power supply shall be 120 volts ± 10 percent, 47 to 420 Hz single phase.

Temperature Range

Each discriminator shall be capable of operating properly when subjected to ambient temperatures between +10°C to +50°C circulating air.

Mounting Panel Size

The overall panel mounting requirements are a standard EIA type rack.

Weight

The weight of the discriminator and power supply shall be kept to an absolute minimum commensurate with good engineering design and the detail requirements for the individual equipment.

Maintainability

Major plug-in printed circuit component boards shall be easily accessible on the discriminator unit when out of the equipment rack.

Special tools and/or extenders required in the maintenance and test of the discriminator assembly shall be made available for procurement upon request.

Test points for monitoring the subcarrier input frequency and/or level and discriminator output shall be available on the front panel to facilitate test and servicing of the unit.

Output Filter Roll-off Rates and Characteristic Response Curves

The output filter characteristic response shall be constant amplitude. The roll-off rate after cut-off shall be 18 dB/octave. It shall be at 500 Hz.

5.11.5 **Signal Conditioning for Reception**

Heart Sounds Conditioning

This unit shall be an amplifier with a flat frequency response of 20 Hz to 600 Hz (3 dB down). It shall have a dynamic range of 60 dB.

It shall have an internal control to adjust the intensity of the heart sounds. The signal-to-noise ratio over the bandwidth with the input shorted through a 600-ohm resistor at full gain shall be less than 48 dB.

It shall have an output jack for a standard high quality dynamic type headphone. The headphones should be well cushioned to shield against room noises. This unit shall be mounted in the control console at all Class "b" and Class "c" stations.

The selection of gain and filter cutoffs will be performed by the examining personnel. The remote consultant listening to the sounds serves to monitor, direct, and consult with the examining personnel. Therefore, there shall be no external controls on this unit.

Spirometry Conditioning

This unit shall be an amplifier with a frequency response of dc to 30 Hz. The gain shall be adjustable by an internal control to give an output range of ±2.5 volts to ±10 volts. The normal full-scale input is ±2.5 volts. The noise level shall be less than 8 millivolts rms over the bandwidth. The filter shall be a constant amplitude type with roll-off after the cutoff frequency (30 Hz) of 12 dB/octave. It shall have an internal offset adjustment such that the bipolar input can be made unipolar (i.e., ±2.5 volts in, to 0 to +5 volts out). When switched to the output of the discriminator, the performance of the discriminator and of the amplifier shall not be degraded.

Electrocardiographic Conditioning

This unit shall interface the output of the discriminator to the high level input of an electrocardiograph (nominal 1 volt/centimeter sensitivity) or other similar voltage recorder. This unit shall be a single-ended input and output voltage amplifier with a frequency response of dc to 45 Hz (3 dB down). The filter limiting the high frequency response shall be of the constant amplitude type with the roll-off after cutoff (45 Hz) of 12 dB/octave. It shall have an internal control to adjust the gain over a 10 dB range. It shall have an internal control to adjust the offset over the entire range at unity gain. The input impedance shall be 100,000 ohms or greater. Output impedance shall be less than 100 ohms. It shall have at least a 10 milliampere output current capability. It shall have overload and short-circuit protection for the input and output. The output connector will be a BNC type (female).

5.11.6 Calibration and Switching For Reception

A means must be provided for readily injecting test frequencies into the discriminator: plus full bandedge, plus 1/2 bandedge, center frequency, minus 1/2 bandedge and minus full bandedge and then calibrating the output voltage of the discriminator. Frequency source and voltmeter need not be an integral part of the telemetry instrumentation but may be a part of the test equipment.

Switching must be provided such that any one of the three signal conditioning units can be switched to the output of the discriminator. Switching must be such that amplifiers and the discriminator do not "lock up." Transients are to be controlled to within reasonable limits.

5.12 Wireless Headsets

The Contractor shall provide wireless headsets for use at each control console installed at Class "a" or Class "b" sites. These headsets are required in order to permit the medical operator (CHM or physician) to listen privately to the program audio channel. When it is desired not to use this device, program audio will be supplied via an amplifier/loudspeaker built into the console. This option shall be switchable using a front panel control.

The wireless headset itself shall be lightweight and self-contained. The console mounted transmitter and the headset receiver must permit clear reception of the audio signal anywhere within the telemedicine room and its immediate vicinity.

The following technical specifications shall apply:

Audio Frequency Response of System:	±2 dB, 300 to 3,000 Hz
Transmitter Power Output:	100 milliwatts (maximum)
Modulation Type:	FM
Receiver Battery:	Rechargeable type with charger unit supplied by Contractor to act as holder for receiver unit when not in use
Battery Capacity:	12 hours of continuous operation
Transmitter Frequency:	As assigned in the 148-174 MHz band.

6.0 OTHER TECHNICAL REQUIREMENTS

6.1 Cable Requirements

All electrical power wiring is to be installed in conduit. Conductor size and insulation breakdown voltage requirements are to be dictated by the peak load expected and in full compliance with the National Electrical Code, local ordinances and institution policy.

With the exception of multiple conductor camera cables (if needed), all cable and wire used throughout the Arizona TeleMedicine Network for internal (building) interconnection shall be of the following types. Camera cable is to be as recommended by the camera manufacturer.

a. Where video or coaxial cable is called for, use Belden 9231 or equal. Install one spare for each pair required.

b. Where RF television cable is required, use Times Wire JT-1412-JM (aerial) or JT-1412-J with armor (direct buried).

c. Where multiple pair audio cables are required or called for, use "Beldfoil" (Belden) 9773 (3 pair), 9774 (6 pair), 9775 (9 pair), 9776 (12 pair), or 9777 (15 pair). Contractor shall select the next highest pair count above that count which will meet the actual circuit requirement. For example, should three pair be needed in a particular instance, install 9774 (6 pair). Should the case be that between 13 and 15 pair are required, install both 9777 and 9773.

Installation of all cable including electrical conduit, power cable, buried RF cable, video cable, audio pair cable and signal wires shall be the responsibility of the Contractor, with one exception. The exception is the wiring at the University of Arizona Medical Center where all work will be performed by the Department of Physical Resources, University of Arizona Medical Center. The Contractor shall accept fiscal responsibility for this work and shall promptly pay as billed by the Department of Physical Resources. The Contractor shall coordinate the scheduling and final specifications as to outlet placement, etc., with the Department of Physical Resources immediately following the award of this contract.

All wiring and cabling within each building and within each room at terminal sites shall be installed in a neat and workmanship like manner. Contractor shall install all cables, wires and conduit above false ceilings or within walls where this is feasible. Where agreed to by the Project Director, cables, wires and conduit may be wall mounted and covered by suitable wood or hardboard channels painted or stained to match the room walls. Contractor is advised that the Project Director retains the right to reject any and all cable installation work on the grounds of poor appearance. The Project Director's decision is to be regarded as final and binding and shall not be regarded as a change in project scope.

Generalized cable route information is shown on the site sketches and floor plans for each station are presented in the segment specification documents.

6.2 Prefabricated Shelters

Where called for, the prefabricated equipment shelters shall include as part of the shelter "package" the following items and specifications. The exception is at Phoenix Indian Medical Center Hospital. Here, exhaust air from the hospital shall be utilized for circulation through the shelter in lieu of the self-contained heating and/or cooling devices at most other sites. Also a foundation is not called for; instead steel skids will bear the load.

Except where noted, the following requirements shall apply at each site where equipment shelters are needed. Also, except where noted, all items are the Contractor's sole responsibility.

a. Building shall rest on a reinforced concrete slab as shall be provided by the Contractor. Footings shall extend at least 24 inches below grade and in no case less than the depth recommended as a result of the test boring done in connection with this project.

b. The structure shall be bolted to the slab using at least six 3/8-inch threaded rods and hardware as installed when the concrete is poured.

c. The equipment housing shall be designed to maintain inside temperatures within the recommended equipment operating ranges for all normal outside ambients. The Contractor may use electric heaters, forced or natural ventilation, standard or reverse cycle air conditioning as required. He may if appropriate, incorporate features such as weather insulation and

ventilated double roofs in the building design. If forced or natural ventilation is used as a principal means of cooling, dust filters or precipitators must be included in the ventilation system. Batteries shall not be located in normally unventilated spaces, but may be located in ventilated spaces partitioned off from air-conditioned radio equipment rooms.

d. Electric power wiring shall be provided for all Contractor installed equipment including heaters, air-conditioners, vent fans, etc. In addition, he shall provide a ceiling mounted receptacle for a 150-watt incandescent lamp and two standard double wall outlets for test equipment and small electric tools for each 100 square feet of floor space. The ceiling lamps shall be controlled by switches near the building entrance.

e. Building and shelters are to be protected from falling ice. Where necessary a steel grid shield shall be employed.

6.3 Towers, Antennas and Radomes

6.3.1 Tower and Support Structures

The Contractor shall supply and install steel towers and antenna support structures as required at all sites except where existing structures may be used. Tower and foundation designs shall comply with EIA Standard RS-222A, with specific allowance made for the wind and ice conditions prevailing at each site. The design of each tower or antenna support structure employed in the system shall include an allowance for the future addition of up to two 8-foot parabolic antennas mounted at any reasonable height and pointed in any direction as specified in segment documents. Antennas are to be included in the wind load calculations made under RS-222A. Contractor responsibility shall include the installation of tower foundations and guy anchors. In the case of roof top antenna support, the Contractor shall provide any required strengthening or reinforcement of roof members.

6.3.2 Test Boring

Test borings to determine the soil bearing pressure capacity where towers and other structures are to be placed may be done at each site where good practice indicates or suggests it. The Contractor shall submit certified copies of all test data to the Project Director for his approval prior to construction at these sites.

6.3.3 Tower Lighting and Marking

If required by Federal Aviation Regulations, Part 77 and FCC Rules and Regulations Part 17, the towers and antenna support structures shall be lighted and marked in accordance with FAA AC 70/7560-1A. A photoelectric device meeting the requirements of Section 13.6(1) of AC 70/7560-1A shall be provided for turning the tower lights on and off.

6.3.4 Microwave Antennas

Antenna mechanical characteristics shall comply with EIA Standard 195A. Unless the Contractor's calculations indicate that larger antenna and higher gains are required to meet the performance specifications of the system as set forth in this document, the antenna positioning and sizes shall be as specified.

6.3.5 Radomes

Unheated radomes shall be installed at each site and on each microwave antenna. Infrared lights shall be installed as needed to reduce ice buildup to within acceptable levels.

6.3.6 Transmission Line

Microwave transmission line mechanical characteristics shall comply with EIA Standard RS-158. The lines shall be pressurized with dry nitrogen. All storage tanks, fittings, tubing, regulators, valves shall be provided as needed at each site.

6.4 Equipment Failure Alarms

Each segment shall have provisions to transfer alarm signals to alarm centers when the appropriate segments are implemented. The alarm centers are specified in the segment documents. Each alarm center shall present the following information regarding the status of stations under its coverage area.

a. Three dB or greater drop in the power of any basic system microwave transmitter.

b. Any basic system transmitter off more than ±0.02 percent in frequency.

c. Loss of received signal on any basic system microwave receiver as indicated by the AGC.

d. Complete failure of a multiplex group.

e. Failure of primary ac power (operation on batteries or standby power generator).

f. Failure of top tower light (if required).

Any alarm produced at the master alarm center readout panel shall cause a flashing light and buzzer indication on the control console located several floors below. The function of this indicator is to summon a maintenance technician to the roof top radio room. Further information as to the site involved or nature of the trouble can be ascertained upon inspection of the master alarm panel.

6.5 Order Wire

A single channel order wire system shall be provided for each of the master alarm centers. The order wire will interconnect with the other center and each center with each microwave station for which it has responsibility. A selective calling system shall be employed so that a person at any microwave station may audibly signal a person at any other microwave station in the same maintenance area.

Order wires shall have a nominal bandwidth of 300 to 3,000 kHz and under unfaded microwave conditions, shall have a 1,000 Hz test signal to rms noise ratio (unweighted) of not less than 35 dB.

6.6 Frequency Shift Key Equipment

Six channels of FSK control equipment shall be supplied in a full duplex configuration at each terminal site (Class "a," "b" and "c" stations). These circuits shall provide remote control of the following dc switches: camera tilt, camera pan, lens zoom, lens focus, lens iris and monochrome bypass.

6.7 Lighting

Two 500-watt quartz lamp fixtures (each with spare lamp) shall be provided and installed at each terminal site. Frosted lamps and diffusers shall be used so as to reduce glare. The fixtures shall be controlled from the console with separate on/off switches for each. The fixtures shall be ceiling mounted and shall be capable of being directed toward any point in the room (manual adjustment).

6.8 System Maintenance Manual and Operation Manual

Fifteen copies of a system maintenance manual shall be delivered prior to the completion of system installation and before any equipment is operated in the field. The maintenance manual shall describe the system and shall cover all routine periodic inspection, testing, alignment, adjustments, fault location and any other maintenance procedures. Test equipment and tools required for system maintenance shall be called out. Periodic maintenance schedules and recommended formats for recording maintenance data shall be included. The maintenance manual shall be directed to persons who have no initial familiarity with the system but who are otherwise qualified engineers and electronic technicians. The manuals shall include detailed plant-in-place drawings for each site. Five Operation Manuals shall be provided at each network terminal site. These manuals shall be directed to nontechnical personnel and shall be explicit in use of the operator equipment. Contractor is advised that some individuals to whom the operational manual is directed have no background in communications or electronics. The Project Director will regard the production of these manuals as a major task item.

6.9 Unit Instruction Manuals

Fifteen sets of unit instruction manuals shall be supplied for each type of unit and major subassembly used in the system. Each unit instruction manual shall include but not be limited to a description of the unit's function, a block and schematic circuit diagram of the unit, a step-by-step explanation of the circuit diagram, tests and troubleshooting techniques, alignment, and repair procedures. Test equipment and tools required for maintenance and repair of the unit shall be called out. The unit instruction manuals shall supplement and may be referenced by the system maintenance manuals.

6.10 Test Equipment

The following list of test equipment will be provided by the Contractor and delivered in good working order to the network sites designated as "Maintenance Centers."

2 ea. Triplett Type 630[1]	Multimeter
1 ea. Hewlett-Packard Type 414A	Auto-Voltmeter
1 ea. Systron-Donner Model 6057	Counter
1 ea. Hewlett-Packard Type 478A	Thermistor Mount
1 ea. Hewlett-Packard Type P932A	Mixer
1 ea. Hewlett-Packard Type 431B	Power Meter
1 ea. Hewlett-Packard Type 400EL	AC VTVM
1 ea. General Radio Type 1304B	Oscillator
1 ea. Hewlett-Packard Type 400EL	Accessories
1 ea. Telechrome 3538	Video Test Set, including all available plug-in modules
1 ea. G.E. Type EX08A	Test Set
1 ea. Hewlett-Packard Type 651	Video Oscillator
1 ea. Tektronix Type 453	TV Oscilloscope
1 ea. 12-inch Trinitron Color Television Monitor (SECAM/NTSC)	
2 ea. 9-inch Monochrome Television Monitors	
1 set, test cords, connectors and miscellaneous adapter and tuning tools	

[1] Use of brand names is purely for descriptive purposes"... or equivalent" is to be implied.

In addition to the above, four sets of hand tool kits shall be provided to the Project Director for distribution and assignment to his technical staff. These kits shall be equal to or better than the JTK-27 kit (without instruments) produced by Jensen Tools and Alloys, Phoenix, Arizona.

6.11 Standby Electric Power

6.11.1 General

The microwave sites selected for the Arizona TeleMedicine Network for the most part are situated near reliable sources of power. Hospital standby circuits shall be used where available. Where standby currents are not available, the Contractor shall furnish the necessary backup power. At each site, Contractor shall provide Sola regulated transformers in each incoming ac line including those ac lines carrying self-generated power. Lightning arrestors shall also be provided in each ac line.

For sites which have no available commercial power, a dual power generator system shall be provided.

To facilitate changeover to standby power a battery float device shall be employed to reduce transients.

6.11.2 Generator Equipment Specifications

The Contractor shall supply and install electric generator sets of not less than 5 kW capacity for providing primary and/or auxiliary power to the microwave sites, as appropriate. The minimum requirements shall comply with EIA Standard RS-173 as modified by the following notes: Contractor is advised that the Project Director may wish to consider propane gas/thermoelectric generating plants as an alternative to the engine generator plants. Contractor will seek the Project Director's approval before purchasing electric generating plants for the Network. Should the Project Director decide to use this alternative, a change order will be issued.

a. The engine shall be a "spark ignition engine" as covered by Section 2.1 of the RS-173.

b. The engine will be adapted to use propane gas as a fuel. Fuel tank capacity shall be adequate for at least 30 days (primary) or 48 hours (standby) of operation under full load.

c. Electrical characteristics shall be 120/240 volt, 30 amp., single-phase, 3-wire.

d. The starting battery shall be provided with a trickle charger that can be operated by connection to 115-volt ac commercial power (where available) when the engine is not operating.

e. Where commercial power is available, an automatic load transfer panel shall be provided to transfer load to the engine generator set within 15 seconds after a commercial power failure.

f. Where commercial power is not available and two engine generator sets are provided, an automatic load transfer panel shall be provided. The load transfer panel shall transfer load from whichever unit had been functioning as the primary source (and failed) to the standby unit. Transfer must not require more than 15 seconds after primary source failure.

g. All generator sets shall be mounted on reinforced concrete pads and (where applicable) properly housed to prevent weather damage. A firebrick wall shall separate the gas tanks from the generator set.

h. A weather protective housing shall be provided for the generator(s) and associated switching equipment.

i. Accessories shall include line voltmeter, line ammeter, running time meter and ac frequency meter. A set of recommended maintenance tools shall be provided with each engine generator set.

6.12 Facilities, Equipment, Services to be Supplied by the Contractor

The Contractor shall furnish all necessary materials, equipment and labor to install and test the system as specified herein. This will include antennas, supporting structures, transmission lines, equipment housing, radio equipment, base band equipment, carrier and multiplex equipment, rectifiers, batteries, emergency power equipment, test equipment spare parts, hardware, and all other related ancillary equipment as required. The Contractor shall provide all required vehicles, tools and machinery necessary for construction, and all test equipment required for performing electrical testing specified herein. The Contractor will be responsible for all necessary transportation, lodging and subsistence of Contractor personnel. The Contractor shall be responsible for compliance with all Federal, State and local laws including requirements for local building permits. However, the Arizona TeleMedicine Network will provide such assistance in these matters as is reasonable and appropriate.

7.0 QUALITY ASSURANCE

7.1 Acceptance Test Plan

Not less than 12 weeks before construction is complete, the Contractor shall submit his acceptance test plan to the Project Director for his review, comment and approval or rejection. Following completion of the project construction work and approval by the Project Director of the acceptance test plan, testing may be started.

7.2 Test Procedure and Schedule

The Contractor shall conduct all inspections and tests required to demonstrate compliance with the requirements of the specifications and according to the test plan (Section 5.1) prior to acceptance of the system by the Network. He shall supply all equipment, material and labor for such inspections and tests. Tests shall be conducted in accordance with an approved test procedure. The Project Director or his designated representative shall be notified 2 weeks in advance of the commencement of any series of tests and shall be provided an opportunity to witness such tests. However, the failure of the Project Director to provide a witness after notification shall not be a cause for delay in testing. The Contractor shall provide the Project Director with a copy of all acceptance test data, and shall submit a final test report to the Project Director for approval.

7.3 Tests at the Factory

Quality control tests shall be performed at the factory on all major components of the system to assure that performance meets the manufacturer's specifications, particularly with respect to those parameters (such as transmitter power, receiver noise figure, etc.) having a direct bearing on system performance. The Contractor shall cause records of such tests to be maintained for at least one year following final acceptance of the system by the Network, and upon request, he shall furnish copies of the test records to the Project Director. All facilities and test equipment required for these tests shall be furnished by the Contractor.

7.4 Preliminary Alignment and Test

The Contractor shall perform all preliminary alignments, adjustment and performance checks prior to the beginning of final acceptance testing. After commencement of

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acceptance testing, only those adjustments prescribed in the published maintenance material supplied by the Contractor shall normally be made on the equipment, and these shall not be made more often than the prescribed intervals. No other adjustments, corrections or equipment modifications shall be made without the concurrence of the Project Director or his designated representative, who will determine whether or not previously taken data requires repeating.

7.5 Site Inspection and Measurements

Each site shall be carefully inspected, preferably by a team having both Network and Contractor representation. The inspection shall include the antennas and support structures, housing and equipment. In addition, the following measurements shall be made at each individual microwave site prior to tests on the system as a whole.

a. Power supply voltages.

b. Power consumption.

c. Transmitter frequency.

d. Transmitter output power.

e. Receiver noise performance.

f. Voice channel test signal output level.

g. Multiplex HF output level.

h. Multiplex intrinsic noise level at voice channel output.

i. All alarm functions.

j. Generator and load transfer panel operation.

8.0 GENERAL CONDITIONS AND INSTRUCTIONS TO CONTRACTOR

8.1 Definitions

The following terms or abbreviations thereof used throughout this document and the proposed contract shall have the meanings herein defined:

1. **Project Director** – The designated individual who acts for the University of Arizona Medical Center and/or the Arizona TeleMedicine Network. The term may also refer to the Project Director's authorized agent.

2. **Contractor** – The designated party or authorized agent acting for the organization responsible for the execution of all works specified in this document.

3. **Network** – The Arizona TeleMedicine Network and/or the University of Arizona.

8.2 Total System Responsibility

The Contractor's service responsibility shall include, but not be limited to, the following tasks.

- Test borings and civil engineering to assure soundness of footings for towers and buildings provided as part of this project
- Frequency search and license application preparation
- Legal service through an attorney familiar by experience with radio law. Such service shall be limited to initial filing and followup and shall not include hearing representation should conflicts develop
- Technical assistance to the Project Director in matters relative to land use for network sites
- Preparation and filing of U.S. Forest Service Special Use Applications

- Installation and test of all hardware, cable and wire as described in these specifications

- Final system performance testing

- Identification and resolution of all interface parameters between his and associated equipment and facilities.

8.3 Completeness of System

The Contractor's overall responsibility shall be to provide a whole and complete system to the satisfaction and in the judgment of the Project Director.

8.4 Qualifications of Contractor and his Proposed Vendors

1. Except as otherwise specified, all basic equipment categories described herein shall be the product of manufacturers who shall have produced similar apparatus for the past 5 years or who shall supply a list of accounts and their installations now rendering satisfactory service. The equipment supplied by the manufacturer must equal or exceed the specified performance characteristics and quality. The manufacturer's performance data and drawings must be submitted for approval to the Project Director prior to its purchase.

2. The microwave equipment and camera manufacturers shall maintain service organizations capable of supplying on-call service, or yearly service contracts. This service shall be available to the user only when contracted for separately. The manufacturer must have the organizational capability and geographic field setup to provide needed service and spare parts within 24 hours.

8.5 Materials and Employees

1. Unless otherwise specified, all materials shall be new. Both workmanship and materials shall be of the best quality.

2. The Project Director shall have authority to order discharged, and removed from the Network project, any employee of any Contractor who shall be found incompetent or in any way detrimental to the best interest of the work.

8.6 **Superintendent, Supervision**

The Contractor shall provide, during its progress, a competent superintendent and any necessary assistants, all subject to the approval of the Project Director. During the course of construction and until final acceptance, the Contractor shall maintain a Tucson office and/or a Phoenix office, staffed during normal business hours. The superintendent and local office manager shall represent the Contractor in his absence and all directions given to him shall be as binding as if given to the Contractor. Important directions shall be confirmed in writing to the Contractor. Other directions shall be so confirmed on written request in each case.

The Contractor shall give efficient supervision to the work, using his best skill and attention.

Immediately after the award of the Contract, the Contractor shall submit an outline experience record of his intended Project Superintendent in order that the Project Director may review his qualifications. The Project Director will notify the Contractor of his approval or disapproval. Until completion and acceptance of the work, the Contractor shall not change or remove the approved superintendent except with the consent of the Project Director.

The Superintendent shall represent the Contractor in his absence and all directions given to him shall be as binding as if given to the Contractor. Important directions shall be confirmed in writing to the Contractor. Other directions shall be so confirmed on written request in each case. The Project Director shall not be responsible for the acts or omissions of the Superintendent.

The Contractor shall maintain order and discipline among the workmen at all times.

8.7 **Preconstruction Submission of Drawings**

1. Two copies of all construction, floor plan and shop drawings, shall be submitted to the Project Director for approval before ordering the items or starting the work involved.

2. All drawings submitted shall bear the stamp of approval of the Contractor submitting same as evidence that they have been checked by him. Correction of specifications and locations of various items, or variations from the requirements of the Contract Documents shall be made or corrected by the Contractor at the request of the Project Director.

3. If the drawings show variations from the requirements of the Contract Documents because of recognized standard practice, or any other reason, the Contractor shall make specific mention of such variation in his letter of transmittal.

4. Where field measurements are required or necessary they shall be made, when possible, before preparation of drawings, and noted as such on drawings.

5. The approval of these submissions by the Project Director will be general and shall be understood to mean that the Project Director has no objection to use of materials or processes shown. This approval shall not relieve the Contractor of responsibility for errors, omissions or deviations from the contract requirements.

Notwithstanding the provisions of these specifications with respect to indicated types and prior utilization requirements, the Contractor shall have the right to propose nonconforming equipment or systems on the condition that the bidder shall acknowledge such factors and shall supply pertinent information concerning the reasons for his choice(s).

8.8 Subcontract (Consultants, Suppliers,etc.)

The Contractor shall notify the Project Director in writing of the names of subcontractors (suppliers, engineers, riggers, lawyers and consultants) proposed for the work, and shall not employ any subcontractor without the prior written approval of the Project Director.

The Contractor agrees that he is as fully responsible to the Project Director for the acts and omissions of his subcontractors and of persons either directly or indirectly employed by them, as he is for the acts and omissions of persons directly employed by him.

8.9 Relations of Contractor and Subcontractor

The Contractor agrees to bind every subcontractor and every subcontractor agrees to be bound by the terms of the Agreement.

8.10 Changes in the Work

The Project Director, without invalidating the Contract, may order, in writing, extra work or make changes by altering, adding to or deducting from the work, the Contract Sum being adjusted accordingly. All such work shall be executed under the conditions of the original contract except that any claim for extension of time caused thereby shall be adjusted at the time of ordering such change.

In giving instructions, accepting and rejecting portions of the work, the Project Director shall have the authority to make minor changes in the work, not involving extra cost, and not inconsistent with the purpose of work.

8.11 Licenses, Permits, Taxes and Fees

Except for FCC application fees, building additions and other items specifically exempted in the Specifications, the Contractor shall pay for all licenses, permits, taxes and fees required for this project; and shall comply with all laws, ordinances, regulations, and other requirements applicable to the work specified.

8.12 Property Damage

All property shall be protected against damage by the Contractor which might occur by reason of his operations in the performance of the contract.

8.13 Scheduling

The scheduling of any work on tribal, private or Government owned premises, buildings or property must be coordinated with the owner or other person in responsible charge in order to minimize the disturbance of activities normally conducted on the premises.

8.14 Final Cleanup

Upon completion of the work, the Contractor shall reconnect any utilities, equipment or appliances removed in the course of work, and replace all fences, etc., moved for the performance of work. Debris and rubbish caused by the work shall be removed and the premises left clean.

8.15 Performance Bond

The Contractor must furnish a performance and payment bond for 100 percent of the total of the contract at the Contractor's expense. This bond shall be in the form of a Surety Bond by a responsible surety company satisfactory in the opinion of the Project Director, guaranteeing the faithful performance of and payment for the work detailed in request for proposal. Bond shall be provided prior to commencing work and shall remain in force for the duration of the contract.

8.16 **Contract Schedule**

The Contractor shall begin work not later than 30 days after the award of the contract. All work shall be complete within 12 months thereafter.

8.17 **Workmen's Compensation and Liability Insurance**

The Contractor shall maintain during the term of this contract the following insurance:

a. Workmen's Compensation and employer's liability insurance as required by statute.

b. Public liability insurance in amounts not less than $100,000 per person and $300,000 per accident for bodily injury, and $25,000 per accident for property damage, including products on completed operation coverage.

c. Automobile liability insurance covering all owned, nonowned and hired vehicles in amounts as indicated in Subparagraph (b) above.

d. Contractual liability insurance covering all liability arising out of the terms of this agreement.

The insurance coverage required shall include those classifications as listed in Standard Liability Insurance Manual, which most nearly reflect the operations of the Contractor. All insurance policies shall be issued on companies authorized to do business under the laws of the State of Arizona.

The Contractor shall furnish certificates of insurance to the Project Director prior to the commencement of operations, which certificates shall clearly indicate that the Contractor has obtained insurance in the type, amount and classifications as required for strict compliance with this paragraph and that no material change or cancellation of the insurance shall be effective without 30 days prior written notice to the Project Director.

Compliance with the foregoing requirements shall not relieve the Contractor of his liability and obligations under this Section or under any other portion of this contract.

8.18 Guarantee

The Contractor shall guarantee his workmanship and materials for a period of 1 year from the date of acceptance by the Arizona TeleMedicine Network. Should defects develop within the guarantee period, the Contractor shall, upon written notice of same, remedy the defects and reimburse the Network for all damage to other physical plant components, whether caused by the defects or the work of correcting same. The Performance Bond furnished by the Contractor as a part of this contract shall remain in effect until the expiration of the guarantee period as assurance of the Contractor's obligation to meet the guarantee.

8.19 Prosecution of the Work

It shall be the duty of the Contractor to notify the various Subcontractors when their presence is required on the job, expedite the flow of materials and secure all necessary inspections. The Contractor shall give reasonable notice to the Project Director when his presence is required for special consultations, examinations or decisions.

8.20 Protection of Materials

Any materials delivered to the job in finished condition, installed in finished condition, or installed and finished before completion of the work, shall be protected from damage until acceptance of the work. Prefinished materials which are damaged either before or after installation, shall be refinished.

8.21 Workmanship

All work shall be executed only by installers, technicians, artisans and mechanics qualified, through experience, in their respective branches and only persons of such qualifications will be permitted to perform the work involved. It shall be understood that work installed contrary to the Specifications or as judged unacceptable by the Project Director shall be removed and replaced without delay, when so directed by the Project Director.

8.22 Care of the Work

The Contractor shall have charge of the equipment and work under construction until the completion and final acceptance of the work under the contract.

The Contractor shall be responsible for all injury to work in progress of construction, and for all property or materials stored on the premises that may be injured or stolen while the work is in his care, and he shall make good all such damage or loss with expense to the Arizona TeleMedicine Network.

8.23 Arbitration

Any controversy or claim arising out of or relating to this contract shall be settled in accordance with the Rules of the American Arbitration Association, which said rules are hereby adopted by reference as much as if incorporated fully herein.

8.24 Testing

All testing of complete work, as required in the specifications, shall be furnished by the Contractor, and the cost of such testing shall be included in his total project price.

8.25 Safety and Protection

The Contractor shall take all necessary precautions for the safety of employees on the work, and shall comply with all applicable provisions of Federal, State, and Municipal Safety laws and building codes to prevent accidents or injury to persons on, about or adjacent to the premises where the work is being performed. The Contractor's job superintendent shall be responsible for the prevention of accidents during construction. The Contractor shall comply with all applicable provisions of the "Manual of Accident Prevention in Construction" of the Associated General Contractors of America, Inc.

8.26 Completion and Acceptance

1. When the Contractor is satisfied that all work required by plans and specifications of the Contract has been completed, he shall notify the Project Director. The Contractor will be notified immediately as to acceptance or rejection of his notification.

2. Upon acceptance of this notification, the Project Director and his Agents will conduct a final inspection to determine what items remain in an unacceptable condition. A report of this inspection will be delivered to the Contractor within 15 days (working days) following acceptance of the Contractor's letter of completion.

3. Upon receipt of this list of unacceptable items, the Contractor shall take immediate corrective action on all items. When all items on list have been corrected satisfactorily, the construction will be formally accepted by the Project Director in a "letter of acceptance." Final payment will then be processed.

8.27 Like Items of Same Manufacturer

For economy of maintenance, all like items (such as all 12-GHz radio equipment) shall be of the same manufacturer.

8.28 Experience

The Contractor shall have successfully completed the engineering design of at least two other medical or educational networks or systems of similar scope within the past 2 years.

The Contractor shall, within the past 2 years, have been selected as prime contractor in the supply and installation of at least one other multiple station television microwave network using remote control switching.

The Contractor shall document the applicable experience as defined above and submit same as may be requested by the Project Director.

8.29 Discrimination

All Federal and State statutes as to discrimination in employment practices shall apply.

8.30 Environmental Protection

The Contractor shall ensure compliance with all Federal and State requirements regarding environmental impact.

8.31 Training

The Contractor shall provide training in equipment repair and operation for 15 persons to be designated by the Project Director. The training will be conducted at the Network's facilities and is to consist of not less than 10 days training in the radio equipment, and not less than

10 days in multiplex console and carrier equipment. The training is to be scheduled at a mutually agreeable time, but before system acceptance tests. Costs of transportation, lodging and subsistence of the persons in training will be borne by the Network. Contractor is advised that the Project Director regards this training as a major task item and of vital concern. Furthermore, the Contractor is to structure his training material for group with varying educational backgrounds.

GLOSSARY OF TERMS AND ABBREVIATIONS

AMERICAN TELEPHONE & TELEGRAPH CORPORATION (AT&T) – A communication common carrier.

AMPLIFIER – Device through which audio, video or telemetry signals are strengthened.

ATTENTUATOR – Device through which audio, video or telemetry signals are decreased.

AUDIO – Of or concerning sound; specifically, the electrical energy representing a sound program or the sound portion of a television program.

AUTOMATIC GAIN CONTROL (AGC) – A circuit which automatically controls the gain of an amplifier so that the output signal level is virtually constant for varying input signal levels. Sometimes referred to as automatic level (ALC).

BAND – A range of radio frequencies within two definite limits and used for a definite purpose; for example, the Standard Broadcast Band extends from 550 to 1,600 kHz. VHF television from 54 to 216 MHz, UHF television from 470 to 890 MHz, international broadcasting uses several bands between 6,000 and 22,000 kHz, and Domestic FM from 88 to 108 MHz.

BANDWIDTHS (pass band) – Describes the frequency range of a communication channel or the frequency range required to convey information through a specific communication medium. For example, the bandwidth of a television channel in the U.S. is 6 MHz.

BASEBAND – In the process of modulation, the frequency band occupied by the aggregate of the information signals used to modulate a carrier.

BAUD – The measure of the rate of transmission of digital data. For a two-level code the baud rate is equivalent to bits per second. Not a good term to use for digital transmission rates, since other than two-level codes are often used.

BROADCAST – Radio or television service on standard assigned frequencies transmitted over an area. Stations may be commercial or noncommercial. For example, one transmitter conveying information to many receivers.

CHANNEL – A range or "band" of frequencies assigned for the transmission of communications signals; in television it is the group of frequencies comprising the transmitted visual (video) and sound (audio) signals.

CHANNEL ALLOCATION – The channel or band in the radio spectrum to which a television station is assigned, or the channel space in the radio spectrum to which a communication service is assigned.

CLOSED CIRCUIT – A private wire or radio circuit used as one means of carrying or conveying from one location to another an audio or television program for specialized audience use.

COAXIAL CABLE (concentric line) – A transmission line formed by two coaxial conductors, each insulated from the other by some suitable insulating material such as air or polyethylene, polyfoam, Teflon, etc.

COMBINING NETWORK – A passive network which permits the addition of several signals into one combined output with a high degree of isolation between individual inputs. Sometimes called "mixer."

COMMON CARRIER – A company franchised to provide specialized communications interconnection services such as telephone, telegraph and other forms of telecommunication, to the public. The telephone company is a typical example.

COMMUNICATIONS CHANNELS – Cable or radio connections through which video, voice, data, telemetry or other information may be transmitted. Important parameters of a channel are bandwidth, noise figure, cross-modulation and fidelity.

COMMUNITY ANTENNA TELEVISION (CATV OR CABLE-TV) – A master antenna array (head end) and the signal distribution system, i.e., the amplifiers, antennas, coaxial cable connecting devices, etc., necessary to distribute several TV signals throughout a community.

COMPATIBLE COLOR SYSTEM – A color television system that permits normal black and white reception of its transmitted signals without altering currently used receivers.

CONDITIONED TELEPHONE LINE – A telephone channel that has been modified for special communication use, usually for more usable bandwidth.

CROSS-MODULATION – A form of distortion where modulation of an interfering station appears as a modulation of the desired station. Caused by third and higher odd order nonlinearities.

DA (DISTRIBUTION AMPLIFIER) – A device used to distribute video signals among several video receivers.

DATA CHANNELS – A communications channel for handling information other than video or voice. For example, digital signals such as teletype and analog signals such as telemetry.

DECIBEL – A unit expressing a power or voltage ratio. Decibel (or dB) $dB_{power} = 10 \log P_1/P_2$; $dB_{voltage} = 20 \log E_1/E_2$.

DEMODULATION – The process of recovering the video, audio and data signals from their respective carrier waves. Extracting the original signal form from the modulated carrier.

DETECTOR – See "DEMODULATOR."

DIRECTIONAL ANTENNA – An antenna radiating or receiving radio waves more effectively in some directions than in others. In microwave engineering: a parabolic "dish."

DUPLEX CIRCUIT – A communications circuit that can transmit and receive.

ECG or EKG (Electrocardiogram) – Measurement of electrical activity associated with the heart.

EEG (Electroencephalogram) – Measurement of electrical activity associated with the brain.

EIA (Electronic Industries Association) – EIA provides recognized standards for a wide variety of communications equipment and systems.

ELECTRONIC STETHOSCOPE – A stethoscope which uses an electronic amplifier and microphone to strengthen the sound of the heart on the exterior chest wall. See "STETHOSCOPE."

EMG (Electromyogram) – Measurement of electrical activity associated with muscles.

EQUALIZATION – A means of modifying the frequency response of an amplifier or network, thereby resulting in a more usable band of frequencies.

FEDERAL AVIATION ADMINISTRATION (FAA) – Federal agency responsible for safe aeronautical practices in the U.S.

FACSIMILE – A data compression technique used to send hard copy material over wire or radio circuits which are of smaller bandwidth than the information content of material. Transmission speed is typically 2 to 5 minutes per picture.

FEDERAL COMMUNICATIONS COMMISSION (FCC) – The U.S. Government agency governing all civilian radio and TV radiations in the air and, to some extent, those through wire or cable.

FIDELITY – The degree to which a system, or a portion of a system, accurately reproduces at its output the essential characteristics of the signal that is impressed upon its input.

FREQUENCY – Number of cycles per second or Hertz.

FREQUENCY DIVISION MULTIPLEX (FDM) – Separation of information by use of several separate frequencies within a communications channel.

GIGAHERTZ (GHz) – 1,000 MHz – Microwave frequencies.

HARD COPY – A printed, physical copy of machine output. For example, reports, listings, documents, summaries, pictures.

HEAD-END – In the Cable-TV industry: the location of facility used in receiving and processing television and radio signals for subsequent transmission by a CATV system to many distant points.

HETERODYNE-REPEATER – In radio transmission, a relay station where the baseband information is not demodulated.

HERTZ (Hz) – 1 cycle per second.

HIS (Health Information System) – the computer-based storage system used by the Indian Health Service.

HUBBING – A commonly used communications term to indicate the routing of communications channels within a network. A network that takes on the appearance of the hub of a wheel with the communication channels configured as the spokes of the wheel.

IHS (Indian Health Service) – The organization within the Public Health Service responsible for the provision of health service to the Indian population.

INTERACTIVE – Terminals or circuits in which the input may be modified by the return of information.

INTERCONNECTION – The electronic system for connecting two or more locations for some type of communications service.

INTERFERENCE – Disturbance in radio reception caused by undesirable signals or stray currents from electrical apparatus, atmospheric static, etc. Also called noise.

INTERMODULATION – A form of distortion where two modulated or unmodulated carriers produce beats according to the frequency relationship $f = nf_1 \pm mf_2$, where n and m are whole numbers. Intermodulation is caused by second and higher order curvature.

IRAC (Interagency Radio Advisory Committee) – The Government organization charged with the responsibility of frequency coordination for authorized users of Federal frequencies.

IRIG (Inter Range Information Group) – An accepted standard regarding telemetry transmission.

KILOHERTZ (kHz) – 1,000 cycles per second.

LIVE – Studio or on-the-spot televising of events and people, in contrast to the transmission of recorded material, such as film or video tape.

LOOP-THROUGH – Term used to indicate series wiring of communication facilities.

MEGAHERTZ (MHz) – One million cycles: when used as a unit of frequency, it is equal to one million cycles per second.

MICROWAVE – Radio waves above UHF frequencies, generally 1,000 to 15,000 MHz. Because of their shortwave length, they begin to behave as visible light.

MICROWAVE RELAYS – Systems used for transmission of video and audio signals by highly directional radio beams at frequencies between 1,000 and 15,000 MHz. Distances of typically 30 miles may be covered by a single link consisting of a transmitter and receiver; longer distances may be covered by multiple links receiving and transmitting the original signal.

MODULATION – The process of impressing audio or video information on the carrier wave (one specific frequency) for transmission through the air or through cable.

MONITOR – To control the picture shading and other factors involved in the transmission of both a scene and the accompanying sound. Monitoring usually occurs in the studio control room and at the transmitter. Also denotes a special type of high-quality receiver or audio system.

MULTIPLEX – A general term for the techniques whereby two or more signals are carried on a single communications channel (wire, radio or other carrier medium).

NETWORK (as, the network) – The Arizona TeleMedicine Network.

NOISE FIGURE – A measure of the noisiness of an amplifier. Noise factor is defined as input signal-to-noise ratio to output signal-to-noise ratio. Noise figure is noise factor expressed in dB. The lowest possible value for a matched system is 3 dB.

PHS – Public Health Service, Department of Health, Education and Welfare.

PLUMBICON – A type of television camera pickup tube, also known as the lead-oxide vidicon. This type is most commonly used in more expensive, professional television cameras, especially in color units.

RF (Radio-Frequencies) – Usually used to distinguish between television channel allocation ult. frequencies and base-band video frequencies.

RECEIVER – An electronic device used to recover a transmitted signal and demodulate it.

RELAY STATION – A station used to receive picture and sound signals from a preceding station and to transmit them to another relay station or to a television broadcast transmitter.

REPEATER – A device for receiving, amplifying and retransmitting a signal.

SIGNAL – Information transposed into electrical impulses. Two basic signals are involved in television transmission – the picture or video signal and the sound or audio signal. Each signal contains electrical impulses representing the elements transmitted.

SIGNAL-TO-NOISE (S/N) RATIO – The ratio of desired to undesired electronic information usually expressed in decibels (dB).

SLOW-SCAN TELEVISION – Television systems capable of producing still pictures at a reduced frame rate. Bandwidth requirement for this still picture medium is much less than standard television.

SPECTRUM – A range of frequencies of interest, or the information content of a signal expressed in frequencies.

SECAM (Sequential with Memory) – A form of compatible color television whereby the color information is carried on an FM subcarrier near the upper limit of the television channel. The standard used in France.

SECAM-60 – The form of SECAM adapted to the usual United States television scanning pattern of 525 lines, 60 fields, 30 frames.

SPIROMETER – A device used to measure orally the inspired or expired air. The output is indicative of lung function.

TARIFF – A schedule of services and rates files by common carriers with regulatory bodies.

TELECO (TELCO) – A commonly used contraction referring to a telephone company and its facilities.

TELEMETRY – The process of conveying signals from one location to another. May use radio links, wire, cable or other transmission mediums.

TELEVISION – The radio or electrical transmission of a succession of images and their reception in such a manner as to give a substantially continuous and simultaneous reproduction of an object or scene before the eyes a distant observer.

TELEVISION CHANNEL – A band of frequencies 6 megacycles wide in which are contained all of the frequency components of a television broadcast signal (picture and sound).

TELEVISION TAPE RECORDER – An electromechanical device for storing television program material on a magnetic tape.

TERMINAL – (1) A point at which information can enter or leave a communication network, and (2) an input/output device designed to receive or send source data in an environment associated with the job to be performed and capable of transmitting entries to and obtaining output from the system of which it is a part.

TRANSMITTER – The electronic device with sufficient energy to convey a signal through a transmission medium.

STETHOSCOPE – A mechanical device used to amplify the sounds on the chest wall produced by the heart.

VCO (Voltage Controlled Oscillator) – A type of device in which the frequency of the carrier wave is changed according to the varying voltage of the input signal.

VIDEO – Of or concerning sight. Specifically, those electrical currents representing the elements of a television picture.

VIDEO SIGNAL – The frequencies generated by the scanning of a scene or image plus the synchronizing pulses involved.

VIDEO TAPE – A magentic tape for recording television signals.

VIDEO TAPE RECORDER (VTR) – Originally a proprietary name of the Ampex Corporation for a television tape recorder. Currently a common generic term for the technique.

VHF (Very High Frequency) – Normally between 30 to 300 MHz.

VOICE GRADE CHANNEL (Voice Circuit) – A channel suitable for transmission of speech, digital or analog data, or facsimile, generally with a frequency range of about 300 to 3,000 cycles per second (hertz). A "voice slot."

VSWR (Voltage Standing Wave Radio) – Reflections present in a communications cable, wire or waveguide due to mismatch (faulty termination) combine with the original signal to produce voltage peaks and dips by addition and subtraction. The ratio of the peak-to-dip voltage is termed VSWR. A perfect match with zero reflections produces a VSWR of 1. For freedom from ghosting, most matches in a CATV system must have a VSWR of 1.25 or less.

WAVEGUIDE – The transmission path between microwave antennas and transmitters and/or receivers. Similar to coaxial cable, but does not require a center conductor.

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